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CHILDREN S USE OF KNOWLEDGE OF RESULTS IN THINKING.
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*INFORMATION PROCESSING, *PROBLEM SOLVING, *LOGICAL THINKING, *CHILD DEVELOPMENT, *PROGRAMED INSTRUCTION, LEARNING EXPERIENCES, THOUGHT PROCESSES, CREATIVE THINKING, INSTRUCTIONAL TECHNOLOGY, INDIVIDUAL INSTRUCTION, ABILITY, LOS ANGELES, CALIFORNIA

A SERIES OF EXPERIMENTS WAS DESIGNED TO STUDY THE VALUE OF TEACHING CHILDREN SUCH A COMPLEX PROBLEM-SOLVING STRATEGY AS TO USE KNOWLEDGE OF RESULTS AFTER A PERFORMANCE TRIAL TO REJECT MORE THAN ONE HYPOTHESIS AT A TIME (MULTIPLE HYPOTHESIS STRATEGY). APPROXIMATELY 150 THIRD-GRADE CHILDREN WERE DIVIDED INTO 3 GROUPS--THOSE TAUGHT THE MULTIPLE HYPOTHESIS STRATEGY, THOSE TAUGHT TO SELECT A HYPOTHESIS AND STICK WITH IT UNTIL PROVEN WRONG (SINGLE HYPOTHESIS STRATEGY), AND THOSE GIVEN NO STRATEGY INSTRUCTION WITH AND WITHOUT OPPORTUNITY FOR PRACTICE. INSTRUCTION AND TESTING WERE CARRIED OUT BY MEANS OF AUTOINSTRUCTIONAL PROGRAMS WITH COMPUTER-GENERATED SEQUENCE. THE EVIDENCE INDICATED THAT INSTRUCTION IN PROBLEM-SOLVING STRATEGIES WAS SUPERIOR TO UNGUIDED DISCOVERY. RELIABLE DIFFERENCES BETWEEN MULTIPLE AND SINGLE HYPOTHESIS STRATEGIES WERE NOT OBTAINED. MULTIPLE HYPOTHESIS STRATEGY INSTRUCTION WAS CONCLUDED TO BE NOT DEPENDABLY INFERIOR TO THE SINGLE HYPOTHESIS STRATEGY. INDIVIDUAL DIFFERENCES IN ABILITY AND AGE, HOWERVER, CORRELATED WELL WITH ALL THE TESTED STRATEGIES. (WN)

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CHILDREN'S USE OF KNOWLEDGE OF RESULTS IN THINKING

Cooperative Research Project No. 2477

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Los Angeles, California
1966

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FOREWARD

For a long time, research in learning has been carried on in the psychological laboratory at a highly theoretical level. The controlled conditions, the special environment, and the careful manipulation of experimental treatments which characterize this type of research have often led educators to feel that the findings are not particularly relevant to the problems of the classroom teacher.

There are many important questions, however, which can be profitably investigated in an appropriate school setting. The vast number of such inquiries is one index of the extent to which this need has been recognized. Another index of this change is the fact that more and more educational innovations, in terms of both instructional procedures and materials, are now being welcomed by school personnel. While the climate for research has thus become increasingly temperate during the past few years, there are many problems of administration, and inconveniences which result when everyday classroom routines are impinged upon, that should not be minimized.

It is with the acute awareness of the problems involved that the principal investigators and the director of Project 2477 wish to express gratitude for the continuing cooperation of the two school systems whose understanding of the need for exploratory research made it possible to carry out the investigation. Mr. Thomas Reece, Superintendent of West Elementary District, who has been so helpful in several other University of California, Los Angeles, research programs under the United States Office of Education, again was unstinting in his efforts. By his own recognition of the value of educational research he has assured the cooperation of the staffs in the schools allocated to the project.

Mrs. Margaret Johnson, Principal, and Mr. Sidney Carp, Vice Principal, were especially patient and long-suffering, having hosted both the two pilot studies as well as the first of the major experiments of the project.

Mrs. Lois Fleming has also had previous occasion to provide research facilities to the University of California, School of Education, and has amply demonstrated her willingness to share in the research enterprise.

Mr. Kenneth Peters, Superintendent of the second school district involved in the project, Dr. Isabel Dible, his Director of Research; and Mr. Frank Scott, Principal of the school at which the research was carried out, have had a shorter history with the research project, but their willingness to cooperate was amply demonstrated.

Not only were all the teachers and clerical personnel unfailing in their patience with the unavoidable inconveniences occasioned by the experimental procedures, but they also actively demonstrated their real interest by asking for and attending demonstrations of the experiment. The parents of the children who also attended these demonstrations, and finally the children themselves, have made invaluable contributions to the course of the research. Hopefully, a little more light has been shed on the intriguing question of complex human learning.

CHAPTER I: INTRODUCTION

A great deal of interest in recent years has been expressed in the cognitive development of young children. During the past decade, a large number of studies in early childhood development have lent considerable support to the possibilities of greatly improving the competencies and motivations with which children approach the learning situation. These findings have suggested that the intellectual capabilities of the young child are receiving insufficient stimulation in the early grades. The lack is not in terms of the specific content but rather in the level of complexity which the teachers expect of the child.

In reviewing the work stimulated by the theoretical formulations of Piaget, Hunt (1961) has emphasized the critical importance of teaching information-processing skills. He points out that the cultivation of the intellect may best be facilitated by providing young learners with the opportunity for asking questions and dealing with the answers they are provided.

The purpose of the project reported here was to explore the possibilities of teaching young children strategies which would improve their efficiency in solving problems. Children generally adopt a random approach to learning, failing to profit from much of the information which is available to them. A number of investigators (Braley, 1963; Hovland and Weiss, 1953; Donaldson, 1959; Smoke, 1932) have indicated that most people do not use all the information given when they are engaged in a problem-solving task.

In this investigation, therefore, children were instructed in two different strategies for information processing, one at a more complex level than the other. Each of these was compared to a procedure which provided experience in the task without systematic strategy instruction. The project was also concerned with determining whether the level of mental ability might be considered an important factor in the acquisition of such skills.

A major assumption of the project was that these skills result from a long history of learning to deal with a variety of new tasks. Although this experiment, by usual research standards, involved a comparatively long period of instruction, it represented only a sample of what a systematic program might be expected to accomplish over a long range application. The scope of problems to which the strategies were applied during the experimental training was therefore restricted to a limited number of situations so that the treatment effects could be more readily assessed. Inherent in this approach was the assumption that the cognitive development of the child is susceptible to environmental manipulation, rather than an invariant sequence of stages.

In this context, how much guidance to provide students during the learning process becomes a question of critical importance. It would appear that learners who have not acquired a system for handling new information need considerable guidance to promote this ability. If children are expected to discover solutions without help, they must have previously been given the opportunity to develop efficient systems for coping with problem situations. Thus learning by "discovery" may be effective if children have previously learned how to discover, but ineffective if such prior learning is absent. Without some adequate procedure for discovery, blind trial-and-error behavior may result.

It would seem most plausible that an important way in which children's abilities to learn might be increased is by helping them understand how to use knowledge of results more effectively. In many situations in school the feedback which the child gets is not primarily a motivational one. It need not be looked upon as a reward; instead, the knowledge of results can be used simply to provide information. The child learns how to interpret data rather than a general tendency to engage in a certain class of behavior. In this way, knowledge of results serves as a discriminative stimulus and is related to the formation of learning sets. An important question then is whether young children can be taught to use strategies in the solution of problems.

Where there are only two choices, as in a discrimination learning set situation, the knowledge of results obtained on the first trial is sufficient to solve the problem. In Harlow's experiments with primates, one-trial learning was attained after practice with a number of similar tasks. It is interesting to note that the trained animals were more apt to be correct on the second trial if the choice selected on the first trial was incorrect.

A common strategy used for two-choice problems is to select one rule or hypothesis as the basis for matching and to continue to use it until it fails to work, at which point another possible solution is selected for testing. This has been characterized in gambler's terminology as a "win-stay, lose-shift" procedure. If the subject keeps track in a systematic manner of the hypotheses tested and rejected, his behavior might be considered non-replacement or "intelligent guessing." Frequently, due to poor information processing or inadequate memory storage, hypotheses found to be incorrect are not discarded. Instead, they are replaced in the population of possible hypotheses and tried again at a later time. This trial-and-error behavior might be described as hypothesis-testing-with-replacement, or "blind guessing." While an appreciable proportion of successes are possible on a purely chance basis, neither of these approaches makes full use of the information available from knowledge of results.

Where the nature of the subject matter permits, an alternative and more efficient approach is for the learner to test several hypotheses on each trial. For this procedure, knowledge of results is used to dichotomize successively the repertoire of solutions into those which are possible and those which are not, and thus must be eliminated. In this fashion the sophisticated learner is able to halve the population of available responses for each step in the data processing, and is able to "zero in" on the correct solution in half the number of trials.

An important feature of this procedure is that the reward or punishment contingencies of the child's responses are postponed. If during the early stages of problem-solving activity, the child is responding in order to obtain information, and does not become ego-involved by committing himself to a selection which can only be correct by chance, there is an increased likelihood that exploratory and question-asking behavior will be adopted in the future. Fear of embarrassment or failure, which plays such an important role in even the youngest child's willingness to participate in classroom recitation, becomes minimal when the initial responses to problem-situations are viewed as information-processing. Perhaps in this way the child may learn to enjoy the intrinsic reinforcement of competence in intellectual pursuits, rather than seeking the extrinsic reinforcement of approval based upon the chance production of correct responses without understanding.

CHAPTER II: REVIEW OF THE LITERATURE

The importance of verbal learning, especially its relationship to the development of intelligence and cognitive competencies, has brought to bear on this question the efforts of workers in a number of different but cognate areas. In reviewing the experimental literature, therefore, it is helpful to utilize a framework which will relate the relevant findings to major questions of the present investigation. Report of the research will thus be subsumed under four topics: 1) the ontogeny of cognition; 2) the value of verbalization in problem-solving; 3) the use of strategies in problem-solving; and 4) the role of guidance in strategy instruction.

1. The ontogeny of cognition.

The work of Piaget has inspired a great many investigations directly concerned with how children develop concepts. The essence of his theory is found in two sources, Piaget, 1953 and 1961, but a more specific application to concept formation, and some of the data from which he draws his conclusions, are available in Piaget, 1928.

The basic postulate is that the genesis of human thought goes through a series of stages, each of which is prerequisite to the next. "The first operations only appear between 7 and 8 years, on the average, and in a concrete form...whilst verbal or propositional operations only arise toward 11 and 12." (1953, P.13) According to this thesis, most of the children used in the experiments of the present study, would be still in the "pre-operational" stage. Thus Piaget seems to view conceptual behavior in terms of logical operations which are functionally related to developmental patterns.

A sampling of experimental investigations of Piaget's hypotheses provides an almost equal number of supporting and challenging results. Ausubel and Schiff (1954) found that young children who had been taught the principle of the fulcrum in terms of a teeter-totter were ready to accept the color of the balancing weights as the basis of operation. However, older children refused to accept this explanation. Both Elkind (1961) and Lovell and

Ogilvie (1961) found the development of the concept of physical volume to be age-related. This also applied to the conservation of mass and weight.

Smedslund (1961) demonstrated that children who had been taught the concept of conservation of weight under experimental conditions gave up the concept and reverted to more primitive perceptual strategies; however, only about one-half of a second group who had already acquired this concept were induced to accept inferior interpretations of the conservation phenomena. Smedslund infers from these results that concepts learned by means of external reinforcement do not have the functional properties of normally acquired "logically necessary" concepts.

An extensive series of investigations by Morf, Smedslund, Vinh-bang, and Wohlwill also supports the position that while children can be taught specific associations, they must have reached the stage of classification in order to be able to generalize this learning. A similar finding was reported by Ervin (1960) who taught third and fourth graders a strategy involving a physical principle, but could not obtain transfer in a mirror-reversal situation. Wohlwill and Lowe (1962) could find no transfer to a verbal test of conservation of number after children had been taught this concept under three different experimental procedures. Wohlwill (1963) concludes that "...in young children the transfer effects to be expected from experience designed to orient the subject to the differentiating aspects of a set of stimuli are likely to remain fairly specific." (P. 12)

An equally respectable body of evidence throws some doubt as to the defensibility of a theory of invariant stages in cognitive development. Furth (1963) found that conceptual control was related to intelligence but only minimally associated with age or language. Arnsdorf (1961) found that children could profit from systematic instruction in the time concepts involved in the social studies. The effects of instruction were also demonstrated by Coxford (1964), with the reservation that such instruction could only advance a child from one stage to the next, and could not be expected to bridge over a missing stage of development. Dodwell (1961) working with number concepts with children 5 to 8 years old (kindergarten through second grade), found little evidence of a consistent progression through the stages postulated by Piaget. Dienes (1959), who confirms Bruner's (1960) statement that "any subject can be taught to any child in some honest form" (P.52), found that most children could be taught complex numerical concepts. This has also been demonstrated by Keislar (1961).

Keislar and McNeil (1961) have taken the position that "children can be taught to give scientific explanations of physical phenomena if they learn a theoretical language for dealing with such events." (P. 73) They found that first grade children could learn an abstract scientific language, and that they could then "learn to use this language as segments of the chain of intraverbal responses in the explanation of the physical phenomena of evaporation and condensation." (P. 82) They also demonstrated that these children had acquired general understanding and not merely rote associations.

Additional evidence which is interpreted as being contrary to the ontogenetic theory is provided by Klingberg (1957); Ling (1946); and Salmina (1960). Zinchenko (1959) has obtained results which show that first graders cannot use classification spontaneously, but they can be taught this skill.

Working with kindergarten children, Ojemann and Pritchett (1963) showed that carefully planned learning programs could significantly affect the development of the concept of specific gravity, and that Piaget's stages do not hold for a large number of these children when a planned learning program is used. Finally, Anderson (1965) has demonstrated that children given appropriate and sufficient training are able to learn a problem-solving skill. He concludes that "reasoning and problem-solving capabilities are best conceived to consist of repertoires of behavior, modifiable in accordance with principles of learning, instead of inaccessible structures and processes...instruction based on this presumption is feasible." (P. 293)

Such findings suggest that attempts to teach complex operations to young children should not be considered unprofitable or wasteful without further investigation into the types of materials and programmed sequences which may provide the basis for the acquisition of broad problem-solving abilities at an early age.

2. The value of verbalization in problem-solving.

To deal effectively with errors the child must be taught how to profit from feedback information. One technique for accomplishing this is through the use of verbal mediators. Many studies have demonstrated that conceptual behavior of children is facilitated when appropriate verbal responses are acquired.

A very early study by Pyles (1932) found that children demonstrated superior performance in discriminating named over unnamed nonsense figures. This line of investigation was almost completely ignored until Birge (1941) demonstrated the role of mediating responses in conceptual behavior. Young children who were taught to call two very different stimulus objects by the same name (a nonsense syllable) were more likely to generalize a reaching response than if the objects were given different names. The likelihood of such generalization was increased when the children were required to say the name out loud.

G. N. Cantor (1955), in a very similar type of experiment with pre-school children (3 to 5 years), found that those who had learned to associate different names to stimulus objects were superior in a transfer task with these objects than children who were taught to attend to relevant stimuli pattern but had no distinctive labels for them. No significant effects attributable to age levels, within the limited range of the study, were produced.

Dietze (1955) taught one group of kindergarten-age children distinctive nonsense syllables as verbal labels for similar stimulus objects, and another group similar-sounding syllables for the same objects. The group which had learned the distintive labels were significantly superior to the similar-label group in all measures of learning and transfer.

This study raised the question of whether "acquired distinctiveness of cues" could be enhanced by using verbal labels. While not designed to test this, the experiment of Carey and Goss (1957) added some light here. One group of pre-school children learned common familiar words as labels; another group learned nonsense syllables. Although both the familiar word and the nonsense syllables were conditioned to the same criterion, the familiar word facilitated the transfer task of block-sorting, whereas the nonsense word did not.

Eisman (1955) taught a group of young children to associate a different familiar-word label to each of three pairs of blocks. The only basis for associating a particular color with a particular shape was the verbal label which had been conditioned to both blocks of the set. In four different situations, these children consistently demonstrated transfer based on the common verbal mediator. There was no attempt to determine whether there was any awareness of the conceptual basis on which the responses were made.

Jeffrey (1953) tested whether a verbal response mediator or a motor response mediator was more effective with young children, and found verbal mediators significantly superior to motor mediators in obtaining generalization. In addition, it was found that a control group which had been given the motor response training but had not been permitted to make this response during the transfer task performed significantly better than chance. This might indicate that some covert verbalization had accompanied the motor response learning, and that the "detachable" stimuli had remained effective even while the motor response was inhibited.

Muehl (1961) applied the mediation hypothesis to the teaching of reading skills. Young children, taught to discriminate letter forms and associate the letter names before seeing them in words, were superior in word recognition. Following this line of investigation, Hendrickson and Muehl (1962) tested the effect of motor pre-training and verbal labeling. All children were given pre-training in pressing the left lever for an arrow pointing left (the d direction), and the right lever for the arrow pointing right (the b direction). They then learned to associate a different familiar word with b and d. However, the words used were not related to the letter. These children were divided into three groups. One was given consistent motor training, another inconsistent motor training, and a third, given training with colors, was used as a control. The results showed no difference between relevant or non-relevant pre-training, but any type of motor pre-training was superior to none at all.

A whole series of experiments (cf. Kendler and Kendler, 1961, 1962, and Kendler, Kendler and Wells, 1960) is directly concerned with studying reversal and non-reversal shifts as an approach to the understanding of concept acquisition in young children. The theory is that in a reversal shift the appropriate verbal labels, developed during the preliminary discrimination training, remain relevant and facilitate learning, whereas in a non-reversal shift new labels must be acquired while the old labels produce interference. If reversal learning is obtained more quickly than non-reversal learning, it is presumed that the verbal mediators are operative. With infra-human animals and very young children, where verbal mediators are inoperative, non-reversal shifts were more easily acquired than reversal shifts. Somewhere between the kindergarten and first grade there is a transition, and reversal shifts become easier for more and more children.

Spiker (1956) hypothesized that learning discriminable verbal responses to a given set of stimuli will facilitate learning motor responses to these same stimuli. Young children were taught a different name for each of two similar stimuli in a pre-training session. A control group was given perceptual discrimination experience with the same stimuli, but without learning names for them. The hypothesis was confirmed with the younger children, but there was no significant difference between naming and discrimination experience with older children.

The results were interpreted in terms of acquired distinctiveness of cues, which assumes that learning of the distinctive (verbal) cues for stimuli makes them functionally more discriminable. The acquired distinctiveness may result from the use of stimulus names in rehearsing the S-R connections during the inter-stimulus interval. This presupposes mediation, since there would be no facilitation unless the stimulus name mediated the appropriate response when the stimulus was presented. Older children were able to supply their own distinctive labeling responses, but younger children were considerably assisted by the pre-training in labeling.

Norcross and Spiker (1957) found that pre-training in attaching verbal labels to stimuli facilitated transfer with young children, and (1958) that this transfer could be either negative or positive, depending on the experimental conditions. Spiker (1959) suggested that this pre-training might be effective even when verbal mediators were not available, as with very young children, by minimizing failure-produced responses.

Like Dietze (1955), Norcross (1958) tested the hypothesis that facilitation in a transfer task may be predicted as an increasing function of the distinctiveness of the response-produced stimuli (cues). The results confirmed the hypothesis---more correct responses were made to pairs of stimuli for which dissimilar nonsense names had been learned.

The investigation of Weir and Stevenson (1959), closely related to that of Spiker (1956), tested the assumption that the lack of difference attributable to verbal labeling with the older children was due to the fact that they were able to supply their own mediators. These investigators found that instructions to overtly verbalize the mediators facilitated learning at all age levels tested. They speculated that the non-verbalizing older children develop more complex hypotheses which interfere with simple solutions. In such cases, the implicit verbalization of the wrong hypothesis would interfere with acquisition of the correct response.

The facilitating effect of pre-training verbal labels with young children is supported by Steigman (1960), Lacey (1961), and Shepard (1957). A number of other studies recognize the effectiveness of pre-training with verbal labels in general, but have some reservations when it is used in experiments with young children.

Ruzskaya (1958), while concluding that the most important factor in concept formation is the verbal sign, commented that labels were particularly important with the older (7 year old) children, as compared to younger (3 year old) children.

Jeffrey and Kluppel (1962) noted that pre-training with relevant mediators may have no facilitating effect on the subsequent learning of the concept. Kendler (1963) also pointed out that the child's possession of a concept label was no guarantee that the child had acquired the concept. Norcross (1958) concluded her study, which generally supports the effectiveness of verbalization, with the caution that the cue-function is dependent upon how well the cue has been learned.

To explain these findings, as well as similar negative results in other studies, Reese (1962) advanced a "mediational deficiency" hypothesis. Based on results of experiments with various types of verbal mediation problems, his position is that there is a deficiency in mediation in young compared with older children. This is related to the fact that the critical age for occurrence of mediation may be different for different experimental situations, and for different concepts.

Particularly pertinent for the present investigation is Reese's point that with a well-learned concept there is no deficiency in mediation as a function of age, and with less well-developed concepts there is a deficiency at any age. Finally, if mediation is considered a voluntary process which can, in a sense, be externalized by preliminary rehearsal of verbal labels, then instruction in the use of the labels should facilitate transfer. If mediation is an involuntary process, instructions should have no effect. However, if in any particular experiment instructions are found to have no effect, the conclusion cannot be drawn that mediation is an involuntary process. The lack of effectiveness of labeling may be more simply attributed to inadequate experience with the verbal cues.

Murdock (1960) confirmed previous findings that learning and transfer are facilitated with verbal responses, that verbal cues are more facilitating than motor responses, and that distinctive cues produce greater transfer than similar cues.

With respect to previously conditioned verbal mediators, Osler and Fivel (1961) discovered that neither C. A. (age groups 6, 10, and 14) nor the position of the label in the concept hierarchy (concrete to abstract), produced any differences in learning. The most significant finding was that high I.Q. children tended to be "sudden" learners. Osler and Trautman (1961), following up this study, concluded that the brighter children used concept labels as verbal mediators to test hypotheses, whereas normal children attained the concept through rote association.

Kurtz and Hovland (1953) presented familiar objects to elementary school children, and asked one group to locate and circle a particular object on a sheet of pictures, and a second group to circle the object on a sheet of names, and to pronounce the name aloud. In a one-week retention test, the group which verbalized the name was significantly superior in recall and in number of correct responses. Gagné and Smith (1962) suggests that verbalization becomes more important as the complexity of the problem increases.

A pilot study carried out for the present project (see Appendix A) concurred with the preponderance of evidence which shows that verbalization facilitates the use of appropriate concepts, whether these concepts are familir or acquired during the course of the experiment.

Although there seems to be consensus that verbalization may facilitate concept learning with very young children, the relationship of this variable with age and problem complexity needs further investigation.

Wohlwill's (1963) statement provides a fitting caution with which to close this section:

> There still remains a question whether the acquisition of verbal mediators in and of themselves operates to change the learning and transfer process or whether they represent rather an external manifestation of more general cognitive changes taking place during the course of the individual's maturation. (P. 20)

3. The use of strategies in problem solving.

While the ontogeny of concept formation and the influence of verbalization in mediational processes are closely related to problem solving, the major focus of the present investigation is on the development of those organized or systematic sequences of behavior which are customarily referred to as "strategies." As Anderson (1965) has pointed out, "three processes--discriminative control of problem-solving behavior by task cues, control of behavior by response-produced cues, and selection of forms of behavior by reinforcement--are sufficient to account for the coordinated, purposeful character of some problem-solving behavior..." (P. 285) Children were taught a basic strategy which has been shown to be of value in many scientific and experimental investigations: that of holding constant all relevant features of a problem except the one being manipulated. The study demonstrates that, when presented with suitable training, children will acquire and transfer a rather advanced, complex problem-solving skill.

Weir (1964), in his discussion of age differences in problem-solving, notes that younger children do not use the same type of strategies as older children. This may be due to age-related differences in the ability to handle language. However, Bruner postulates that there are "styles" of problem solving which are more or less efficient with certain types of problems. For instance, certain individuals, whom Bruner identifies as "scanners", do better on disjunctive problems where the ability to retain and use both negative and positive information is of particular advantage. "Focusers", on the other hand, are apt to be superior where the memory storage factor is minimal.

Kagan, Moss, and Sigel (1964) also talk about cognitive styles, but relate these to developmental stages. They make the point that the child's initial conceptualizations are global and over generalized and tend to become analytic and differentiated as the child matures. Other investigators, for instance Glanzer, Huttenlocher, and Clark (1963), have related strategies or styles of problem-solving to a number of important variables in the problem itself. Among such factors as type of exemplars (negative or positive), ratio of relevant to irrelevant instances to total number of examples, presence of superfluous information, ordering of examples, amount of information required to solve problems, and rate of introduction of new information, probably the most important effects are attributable to information structure of the problem and memory storage load.

In addition to the work sited above, there is a large body of literature on the question of problem-solving strategies in which more mature students have been used as subjects. A number of studies by Bourne, Trabasso, and Bower fall into this category. It seems however, that findings obtained with young adults who have had a long history of strategy acquisition and application have minimal relevance in studying the young child's ability to learn information-processing skills.

The study of Reynolds, Glaser, and Abma (1964) is nevertheless worthy of note in that a major hypothesis tested was the effect of individual differences in mental ability in the formation of learning set through programmed instruction. The results did not confirm the hypothesis that high I.Q. subjects would not profit as much from programmed instruction as average I.Q. students. However, it was found that the learners in this study were not dissimilar when compared to Harlow's primates:

> When incorrect frame responses occur, the immediate feedback serves as a correction trial. This explanation implies that terminal achievement in linear programming is not solely a function of the opportunity of immediate confirmation of correct responses, but rather that the frames of a program provide both confirmation of correct responses and correction for wrong responses, both of which contribute to producing the desired terminal behavior...under certain conditions, correction is as effective as confirmation in producing learning. (P. 13)

4. The role of guidance in strategy instruction.

The relative merits of instruction vs discovery methods for obtaining cognitive learning have been investigated under many different experimental conditions. Kofsky (1963) noted that in classification tasks children's responses had no systematic reference to the stimuli, even after the basis for classification was explained. The implication was drawn that the verbal mediators supplied by the experimenter had no cue-function at this age level.

Both Luchins (1942) and Weiss (1954) found that verbal instructions which improved the performance of adults and older children were less effective or ineffectual with younger children. The studies of Kofsky, Luchins, and Weiss may be cited as evidence in support of Reese's mediational deficiency hypothesis. White (1963) presents an excellent survey of research on the effects of verbal instructions with young children.

A study by Bruner (1956) showed that children who selected their own mediators as a basis for remembering paired-associate material, were superior to a group who were given the mediators used by the first group. While this has been taken as evidence for the superiority of discovery, all that can be indisputably inferred is that a strong mediator for one person may be a relatively weak one for another. Obviously, the strength of a mediator is dependent upon the individual's history of conditioning with it. As Gagné and Brown (1961) have pointed out, one reason why self-discovery of a principle is superior to instructions is that the learner is forced to express the principle with his own words, which are more meaningful to him.

Corman (1957) related type and amount of information to individual differences in mental ability. In the analysis of the results, Corman stated that the more capable students showed no significant differences in complex transfer tasks as a result of more information about either the rule or the method. In simple transfer, the able students profited most from a combination of information about the rule and the method. For all students, information about the rule did not seem to affect results. However, an inspection of the tables from which these conclusions were drawn shows that the task was so difficult that performance was at a chance level.

All the low-ability students did so poorly (.3 to 1.3 problems solved) that there were no significant differences. The only legitimate conclusion here is that the problems were too difficult for the subjects or the instruction was inadequate.

Kersh (1962) taught one group two rules for solving an addition problem. The other group was given guidance in discovering the rule by themselves. He found that the guided group was superior in a retention test. However, this group was found to have practiced the problems in the interim. Kersh concluded that the discovery method was more motivating.

Haslerud and Meyers (1958), usually cited as supportive of discovery methods, only showed that the percent of improvement in the retention test was greater for the uninstructed group. But in absolute score, they were still inferior to the instructed group. Katona (1940) demonstrated that those who have learned a given principle can generalize this learning to new instances of the same principle, whereas those who have learned a whole series of instances of the principle---but not the principle itself---are unable to solve new instances of the principle, and also are less apt to remember the ones they did learn. The subjects did not, by themselves, derive the principle from a large number of instances; those who were taught the principle were able to use it in new instances, and retained it after a month's time. Duncan (1963) found that increased amounts of instruction decreased the number of overt responses required to solve the problem, but increased the amount of time. It might be pointed out that the type of information given was not very helpful. Neither the way to solve the problem nor the rule for solving it was provided.

Ewert and Lambert (1932) found that increasing the amount of instruction increased the amount of learning---but the amount of improvement was closely related to intelligence. In other words, for the verbal cues to be functional they must be meaningful. Irwin _et_. _al_. (1934) noted the fact that knowing the rule or principle was not enough by itself; it must be rehearsed or practiced in its applications.

Craig (1956) found that the group which received brief verbal instructions during the training period learned and retained significantly more than did the group which had had no help.

Underwood and Richardson (1956) also found that the greater the amount of information given concerning the content or nature of the concepts to be learned, the more rapid was the acquisition of the concepts.

Kittell (1957) demonstrated that children who were given instruction as to both principle and organization of the material were superior in learning, retention, and transfer, to groups given either less or more direction.

Shipstone (1960) presents an excellent discussion of the variables affecting conceptual learning. The information capacity of the human channel is limited. Verbal instructions or rules provide a means by which the sensory input can be recoded into meaningful units. Exploring these relationships with Miller' s "strings"---constructed grammatical sequences---she found that when the task is too difficult, verbal instructions will not help. Otherwise, the optimal use of rules or instructions is to get the subject to extract the maximum amount of information from the examples given.

The effectiveness of verbal instructions as "sets to learn" specific types of concepts, or types or responses, or as verbal cues for the bases of organization of materials, has been demonstrated by Reed (1964), Postman and Senders (1946), Entwisle (1961), Ausubel (1960), Ausubel and Fitzgerald (1961), Mulholland (1963), and Wittrock, Keislar, and Stern (1964).

In the preceding studies, the effects of instructions which provide positive information, usually before the performance of the task, were investigated. Information telling what the concept is, or what it is not, may also have important effects on conceptual learning. Hovland and Weiss (1953) found that subjects identify a concept more readily from positive instances which convey less information, than from negative instances which convey more information about the concept. Donaldson (1959) relates the greater difficulty in utilizing negative information about a concept to the need for structuring the problem so as to be able to understand the implication of the negative information. Cahill and Hovland (1960) found that, while learning from negative instances was difficult, it was possible when the subject knew all the relevant dimensions---that is, if he could use the negative information to successively eliminate wrong hypotheses until only the right one was left.

Friebergs and Tulving (1961) discovered that subjects could be taught to use negative information. Braley (1963) characterized utilization of negative information as a "higher level problem-solving strategy." It puts a high load on memory storage, unless the "relevant cue space" is clearly delimited. Glanzer, Huttenlocher, and Clark (1963) also attributed the greater difficulty of utilization of negative information to heavier memory storage load. But Olson (1963) confirmed the findings of Smoke (1932), that a combination of negative and positive instances produced as efficient concept identification as positive instances alone.

Gagné (1966) cites an experiment in which high school students, who were asked to "discover" concepts with minimal verbal direction, had a great deal of difficulty. He infers that:

> Discovery without guidance makes the learning of concepts a terribly slow process...when mediators have been previously learned...it is considerably easier to arouse their recall by means of some verbal instruction than it is to expect them to be discovered...to expect a human being to engage in a trial-and-error procedure in discovering a concept appears to be a matter of asking him to behave like an ape. (P. 15)

Motivational reactions, related to learning under different amounts of instruction have also been experimentally investigated. Twelker (1964) reported that subjects who had been given neither verbal prompts nor confirmation had the strongest negative reactions to the experiment.

In the series of investigations reported by Wittrock (1964), the experiments were conducted in a teaching-machine setup which the children found highly diverting and exciting. However, it was noted that the "general instruction" groups, which did not often succeed, began to show aversive reactions, and became unwilling to return to the experiment room.

These effects were also noted by Morgan (1944) who found that where no problem-solving information was supplied, the subject became frustrated and did not wish to go on with the experiment.

Thorndike (1935) warned:

> Refusal to supply information on the ground that the learner will be more profited by discovering the facts himself, runs the risk not only of excessive time-cost, but also the strengthening of wrong habits. (P. 147)

Smedslund (1961) notes that the belief in the superiority of discovery via the Socratic method over traditional teaching still rests more on intuitive conviction than well-established experimental evidence.

Chapters III, IV, and V present the details of three experiments designed to test several questions for which research has as yet provided no definitive answers. It is hoped that the experiments carried out in the course of this project will throw light on several factors involved in the teaching of strategies to young children.

CHAPTER III: THE FIRST EXPERIMENT

Acquisition of Problem-Solving Strategies by Young Children and Its Relation to Mental Age[1]

The hypothesis of the first study was that young children could be taught to use systematic strategies in the solution of concept-identification problems. More specifically, it was predicted that children taught to use maximum knowledge of results through a strategy of multiple hypothesis testing would be better able to solve such problems than children taught a single hypothesis strategy, or those given only appropriate experience and permitted to develop their own particular styles of strategy-formation. In addition, it was postulated that the multiple-hypothesis strategy would be more difficult to learn and to use, and for this reason children with higher mental age would do better than those of lower mental age in the application of this procedure to the problem-solving task. Also, if verbalization, or the use of the concept labels as self-cues, made a major contribution to the ability to solve such problems, it was hypothesized that girls would do better than boys under either strategy-instruction condition.

METHOD

Apparatus:

The apparatus used for this study was identical to that used by Stern (1964). It included ten booths, each equipped with earphones, a microphone, and a multiple-choice response panel. The audio-visual program consisted of 35 mm. slides projected on a central screen visible from each booth, with verbal instructions transmitted to each individual's earphones over a tape recorder. This tape also controlled the intervals at which the slides were presented and provided the impulses to initiate the recording cycle. The child was required to respond orally by verbalizing the concept or hypothesis chosen for testing. This naming response activated a relay which turned on a reinforcing light and permitted the child to perform the button-press selection response. A visual display of the responses of all the subjects to each item appeared on the master panel and facilitated monitoring the operation of the equipment.

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[1] The bulk of this chapter is appearing in the next issue of the American Educational Research Journal, 1966.

A complete record of the performance of all children in each group was made by a Clary data recorder on punched paper tape. The paper tape was simultaneously read and punched on IBM cards by a Flexowriter and tape-to-card converter; the data were then analyzed by a computer program.

Subjects:

One hundred twenty third grade children in a West Los Angeles Elementary school were randomly assigned to four groups within two levels of mental age and sex. Attrition due to absenteeism brought the final N down to 110. This group had an average chronological age of eight years four months, and a mental age (based on the Kuhlman-Anderson test) of nine years one month, with standard deviations of four and twelve months respectively.

Experimental Task and Materials:

The task was presented on 35 mm. color slides consisting of a model picture in the top center and two exemplars below (Figure 1). On each slide, the child selected one of the exemplars which matched the model picture on the basis of one of the concepts: number, color, size, or shape. Immediately after his selection, he was told whether he was right or wrong. During experimental training, the problems consisted of the successive presentation of four slides: each slide of a particular problem was to be matched by means of the same concept. The problems were separated by blank slides to show when a new problem was being presented. The task for the child was to use knowledge of results to discover, in as few slides as possible, the correct rule for matching within each problem.

Instructional Treatments:

All instruction and testing were carried out entirely by means of auto-instructional programs using the equipment and materials previously described. Training programs were given for 15 minutes per day over a three-day period. The same sets of slides were used for the two strategy groups and the practiced control; only the taped commentary was different.

The first slides which the children encountered were ones in which only one exemplar could be matched to the model, and in only one dimension. Over the three-day period, the number of concept-dimensions in which the exemplars could be matched with the model

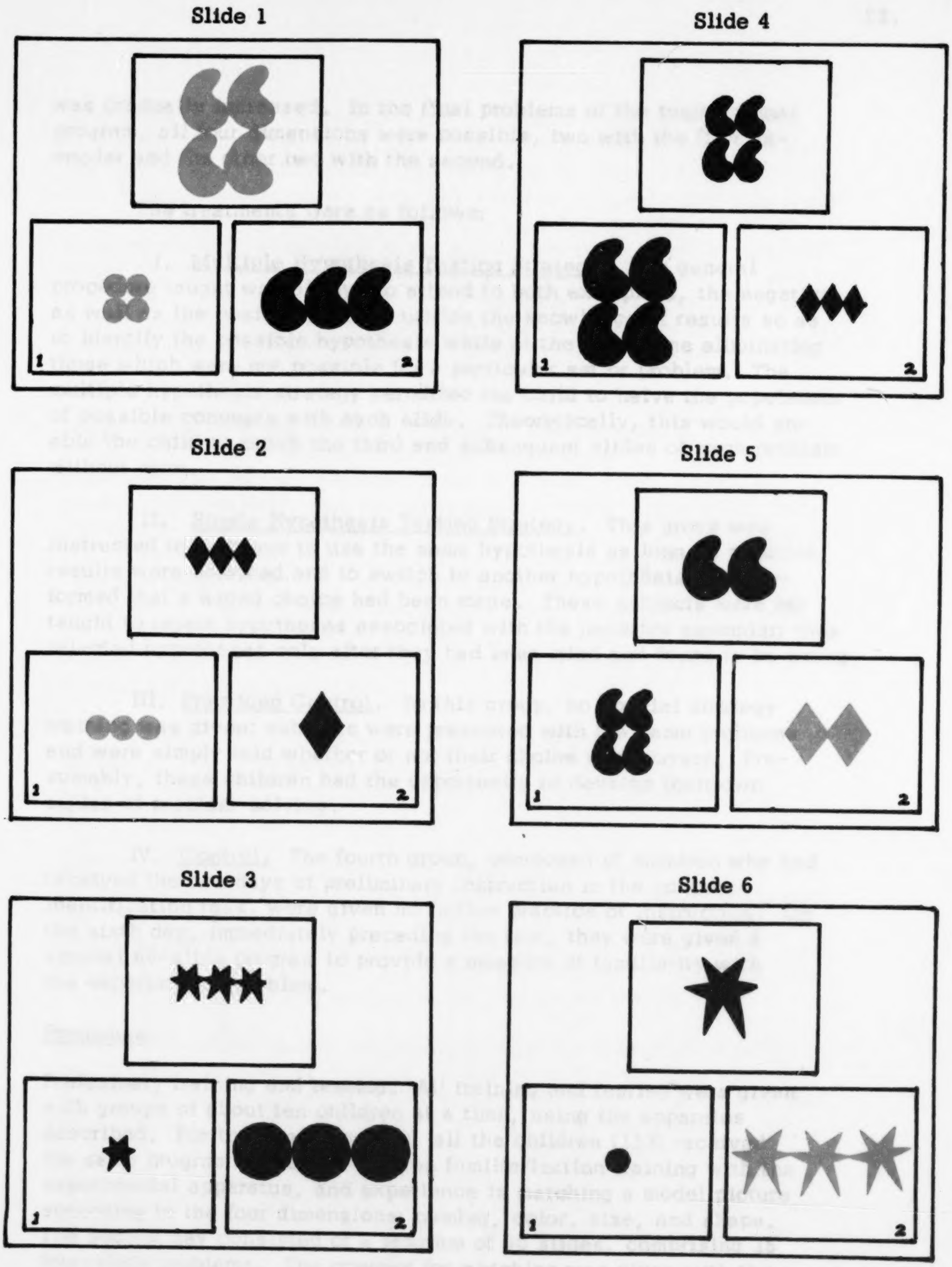
Slide 1
1
2
Slide 4
1
2
Slide 2
1
2
Slide 5
1
2
Slide 3
1
2
Slide 6
1
2

Figure 1. Sample of the Terminal Problems used for all Experimental Treatments.

was gradually increased. In the final problems of the instructional program, all four dimensions were possible, two with the first exemplar and the other two with the second.

The treatments were as follows:

I. Multiple Hypothesis Testing Strategy. The general procedure taught was always to attend to both exemplars, the negative as well as the positive, and to utilize the knowledge of results so as to identify the possible hypothesis while at the same time eliminating those which were not possible for a particular set or problem. The multiple hypothesis strategy permitted the child to halve the population of possible concepts with each slide. Theoretically, this would enable the child to match the third and subsequent slides of each problem without error.

II. Single Hypothesis Testing Strategy. This group was instructed to continue to use the same hypothesis as long as positive results were obtained and to switch to another hypothesis when informed that a wrong choice had been made. These subjects were not taught to reject hypotheses associated with the negative exemplar; they rejected hypotheses only after they had been tried and found to be wrong.

III. Practiced Control. To this group, no special strategy training was given; subjects were presented with the same problems and were simply told whether or not their choice was correct. Presumably, these children had the opportunity to develop their own styles of problem-solving.

IV. Control. The fourth group, composed of children who had received the two days of preliminary instruction in the concept-identification task, were given no further practice or instruction. On the sixth day, immediately preceding the test, they were given a special 60-slide program to provide a measure of familiarity with the experimental problem.

Procedure:

Preliminary training and testing. All training and testing were given with groups of about ten children at a time, using the apparatus described. For the first two days, all the children (133) received the same program. They were given familiarization training with the experimental apparatus, and experience in matching a model picture according to the four dimensions: number, color, size, and shape. The second day consisted of a program of 60 slides, comprising 15 four-slide problems. The concept for matching was given with the first slide, and the instruction was to match the subsequent slides of that problem by the same rule. This provided the basis for selecting one of the two exemplars, and retention of the relevant hypothesis over a short memory span. Only the last four of the 15 problems were scored. All the children (39) who performed below criterion (87.5 percent) were given one day of additional practice. Twelve children failed to achieve this score and were not included in the study since it was felt that these skills were prerequisite to the learning of the problem-solving task. The remaining children were randomly assigned to one of four groups, within two levels of mental age and sex.

Experimental training. On the first day of the experiment, all groups, except the control, received the same instructions for the 32 slides. They were told to "say the rule" (that is, color, size, shape, or number) for matching, into the microphone. Voice relays would then activate the individual response panels and permit the child to press the button for the appropriate exemplar for that rule, and get a reinforcing green light. For all these slides, each exemplar matched the model in one of the four dimensions. Thus, for any slide, both pictures matched the model, but each in a different concept; the correct picture was determined by the concept given as the rule for matching the particular slide.

These individual slides were followed by eight four-slide problems, using the same type of slides (each exemplar correct in only one dimension). All groups were told the two possible rules for each slide.

Multiple Hypothesis training. The instructions were to select a rule for matching, say the rule, and press the button for the picture which matched by the rule chosen. If a green light came on, the same rule was used for the remaining slides in that problem; if a red light, then the other rule was correct. The instruction was to say the other rule for the second slide and to choose the picture for that rule.

The second day of experimental training consisted of slides in which three dimensions could be correct, with the red light always eliminating one of the three. The Multiple Hypothesis group was told, for example, "The rule for the next set can be either number, size, or shape. Say the rule you choose and press the button for the picture that goes with it. If you get a red light it means that size is not the rule for this set. The rule is either number or shape." On the second slide: "Say either number or shape, then press the button that goes with the rule you choose. Either the red or the green light will tell you the correct rule. The red light says it is *not* shape; the green light says it *is* number. Say this rule for the next two slides of this set."

The third and fourth days of experimental training followed the same procedure, using all four concepts. The instructions were of the following nature: "Picture 1 is the same size and shape as the top picture; picture 2 is the same number and color as the top picture. Say the rule you choose and press the button to go with it. If you get a red light, you know the rule is *not* number or color; it must be size or shape." On the next slide the commentary was: "You know the rule must be size *or* shape. Say the rule you choose and press the button. Now the light will tell you which rule is correct. Use the correct rule on all the slides in this set."

Single Hypothesis training. All the instructions on the first day were the same as for the Multiple Hypothesis training, except for the eight problems, for which the two rules possible with each slide were given. However, the strategy here was to select one rule for testing and to use it as long as a green light appeared for the exemplar which matched according to the chosen rule. On the second day, the Single Hypothesis group was also given the three possible rules for the set and told to choose one of these rules for matching. The instruction for this group was: "If you get a green light, try the same rule for the next slide. If you get a red light, try another rule." When all four concepts were possible on any one slide, the instructions were: "There are four ways of matching each slide: number, size, color, or shape. But only one rule is correct for all the slides in each set. Choose a rule for matching. Say the rule you choose and press the button. If you get a red light, try a different rule."

Practiced Control. This group was also given the repertoire of possible concepts for each problem, but the instructions were simply: "Choose one of these rules for matching. Only one rule is correct for all the slides in each set. Say the rule you choose and press a button to go with it. The green light tells when you are right. Match all the slides in the set by the same rule."

Posttest. The criterion test consisted of eight problems of five slides each, of the same type as the last two days of training. Since the response to the first slide of each problem could be correct only by chance, the scoring was limited to the remaining four slides of each problem, providing a total possible posttest score of 32 points.

RESULTS

Means and standard deviations for C.A., M.A., training scores and posttest scores for all four groups are presented in Table 1. The training score was based on the performance during the last day of instruction. Although performance during training reflects the differences in instruction, the results indicate that the Multiple Hypothesis group was significantly superior ($p < .01$) to the Single Hypothesis group, as well as to the Practiced Control group. This is in line with the mathematical probability that this type of procedure would be more effective for the class of problems used. However, the performance on the posttest, during which the strategy cues were not provided, indicates the actual effectiveness of the different instructional treatments. Table 2 contains the means for the subgroups used in the three-way analysis of variance on mental age, sex, and treatment reported in Table 3. This analysis showed a significant main effect for treatment ($F = 9.16$, $p < .001$).

Since there were no reliable main effects due to mental age or sex, the total treatment group means (see Table 1) were compared, using the Newman - Keuls procedure (Winer, 1962). The Single Hypothesis posttest score proved to be reliably higher ($p < .01$) than that of any other group. No dependable difference between the Multiple Hypothesis group and either of the two control groups was found.

While the analysis of variance did not support the hypothesis that difference in mental age would produce an effect on the acquisition of the problem-solving strategies, the correlational data reported in Table 4 may provide some additional insights. All the coefficients presented are positive, but the relationship is reliably different from zero only for the Multiple Hypothesis strategy on the posttest ($r = .41$; S.E. = 20; $t = 2.0$; $p < .05$).

DISCUSSION

The results support two of the hypotheses of the study; that a strategy for solving certain types of concept-identification problems can be taught to young children; and that there is a significantly positive correlation between mental age and the acquisition of the difficult Multiple Hypothesis strategy.

TABLE 1

MEANS AND STANDARD DEVIATIONS ON ALL MEASURES

TREATMENTS	N	CHRNLGICAL AGE M	SD	MENTAL AGE M	SD	TRAINING* M	SD	POSTTEST* M	SD
MULTIPLE HYPTHSIS	26	8-4	0-4	9-2	1- 2	18.12	3.01	18.65	3.35
SINGLE HYPOTHESIS	29	8-4	0-4	9-0	0-11	15.20	3.65	21.62	5.41
PRACTICED CONTROL	27	8-3	0-4	9-1	1- 1	15.37	3.30	17.81	4.14
NO-PRACTICE CNTRL	28	8-4	0-4	9-0	1- 2	NO TRAINING		16.18	2.93

* 32 POINTS POSSIBLE ON BOTH TESTS

TABLE 2

MEANS AND STANDARD DEVIATIONS ON POSTTEST BY TREATMENT, SEX, AND MENTAL AGE

TREATMENT	MALE (HIGH MA) N	M	SD	MALE (LOW MA) N	M	SD	FEMALE (HIGH MA) N	M	SD	FEMALE (LOW MA) N	M	SD
MULTPLE HYPTH	2	16.50	0.71	10	18.70	2.83	10	20.00	3.43	4	16.25	4.19
SINGLE HYPOTH	6	20.00	5.55	6	18.50	5.24	7	23.86	6.31	10	22.90	4.28
PRCTICED CNTRL	6	19.17	5.15	6	18.50	2.81	6	18.33	5.79	9	16.11	2.85
NO-PRACT CTRL	7	16.29	2.69	5	15.00	2.12	6	18.00	4.29	10	15.60	2.32

TABLE 3

ANALYSIS OF VARIANCE ON TREATMENT, MENTAL AGE, AND SEX

SOURCE	DF	MS	F	P
TREATMENT (A)	3	148.54	9.16	.001
MENTL AGE (B)	1	24.79	1.53	NS
SEX (C)	1	26.54	1.64	NS
(A) X (B)	3	10.08	.62	NS
(A) X (C)	3	39.02	2.41	NS
(B) X (C)	1	7.58	.47	NS
(A) X (B) X (C)	3	16.67	1.03	NS
ERROR (WITHIN)	94	16.22		NS
TOTAL	109			

TABLE 4

CORRELATION MATRIX

TREATMENTS	VARIABLE	TRAINING N	TRAINING R	POSTTEST N	POSTTEST R
	MENTAL AGE				
MULTIPLE HYPOTHESIS		25	.38*	25	.41*
SINGLE HYPOTHESIS		28	.16	28	.15
PRACTICED CONTROL		26	.19	26	.20
NO-PRACTICE CONTROL		NO TRAINING		28	.34
	TRAINING				
MULTIPLE HYPOTHESIS				26	.43*
SINGLE HYPOTHESIS				29	.19
PRACTICED CONTROL				27	.44*
NO-PRACTICE CONTROL				NO TRAINING	

*P < .05

The Multiple Hypothesis strategy did not demonstrate the superior performance which was predicted on the basis of mathematical probabilities. While this group was significantly superior to the other groups during training, the children were unable to maintain this superiority under the test condition where the strategy cues were not provided. Evidently these children could not supply the necessary cues for themselves, and could not continue to execute this fairly complex strategy on their own. The three-day training period was insufficient for the average child of this age to acquire a more sophisticated procedure. However, on the whole, children in the higher mental age group tended to be more successful in the application of this strategy than children in the lower mental age group. The children who were taught to use the Single Hypothesis strategy were not only superior to the Control, who had received familiarization training with only limited practice at the experimental task, but also were reliably superior to the Practiced Control who had been given anequivalent amount of practice without strategy instruction. Evidently these third grade children learned to use a technique which they had not previously employed.

Braley, 1964, noted that even college students are not apt to use knowledge of results, which indicate that a wrong hypothesis has already been selected, to infer the correct hypothesis. Testing one hypothesis at a time is obviously a simpler technique to master, and one requiring less change in previously learned behavior. Anderson (1965) demonstrated that bright first-grade children could be taught such a skill. The low correlation with mental age may indicate that by third grade most children have the basic mental ability requisite for this type of strategy. While with many kinds of school problems the Multiple Hypothesis testing strategy may be most efficient, it remains to be determined whether, with more adequate and extensive training, young children can be taught such a strategy without excessive expenditure of time and energy.

CHAPTER IV. THE SECOND EXPERIMENT

Acquisition of Problem-Solving Strategies by Young Children and Its Relation to Verbalization

The first experiment supported the hypothesis that young children could be taught strategies for solving a certain class of concept-identification problem, in that both experimental treatments were superior to the untrained control group. However, neither of the trained groups attained the level of performance which could be expected in terms of the mathematical probabilities of the problem. Also, the group which had been instructed in a theoretically-less effective, but simpler, strategy was superior to one which had been given a more efficient but more complex hypothesis-testing procedure.

In constructing the original programs, certain a priori assumptions were made. First, that difficulty of individual frames is related to 1) the number of ways in which the correct exemplar is like the model, 2) the number of ways in which the incorrect exemplar is like the model, and 3) the number of ways in which both exemplars are like each other.

Based on this logical assumption, the visual stimuli were sequenced from the simplest form, in which the correct exemplar was like the model in all four dimensions and the incorrect exemplar was like the model in all except the relevant dimension, to the most complex, in which both exemplars were like the model in two different dimensions.

Inspection of the results of the training based on this sequencing indicated that while the logic was defensible, there were certain areas which needed further development.

The second assumption was that to evaluate fairly the comparative effectiveness of the two instructional procedures, the visual material should be the same for the two treatments with only the spoken commentary appropriate for the treatment. However, a reanalysis of the two tasks suggested that quite different instructional sequences were necessary. Therefore, as indicated in Table 2, the two programs were not identical at a number of critical points. The basic questions for this experiment were how well children could follow the instructions for the two strategies and how effective the learning would be under each condition.

Before beginning the second experiment, several weeks were devoted to program development. Each phase of the instruction was tried out and tested with about 40 children selected at random from the same school population to be used in the experiment. When the final program was set, several new features had been added. The most important of these was a booklet system by which the factor of memory load could be minimized as an effective variable. In addition, the question of the importance of verbalization was raised. In the first experiment, all the children had been required to verbalize overtly the correct concept before making a selection response based on that concept. The implied assumption, that verbalization would facilitate learning, could not be tested in that design.

PROBLEM

The second experiment was therefore concerned primarily with testing the following hypotheses:

1) Children taught to follow instructions for a complex problem-solving strategy will be better problem-solvers when following these instructions than children following a set of simpler strategy instructions;

2) When these instructional supports are removed, the children taught the more sophisticated strategy will solve the same type of problem more successfully than children taught the simpler strategy;

3) Children who are required to say the correct concept aloud, under either strategy treatment, will be more competent problem-solvers than children who are not taught to supply any overt verbal cues.

METHOD

Apparatus:

The UCLA Group Teaching Equipment, described in Chapter III, was again used.

Subjects:

All the third grade children in a West Los Angeles Elementary School were involved in the study. The approximately 40 children who had participated in the program-development phase were not included in the actual experiment. The remaining 107 children (56 boys and 51 girls), were assigned to four experimental treatments using a stratified-random design based on mental age. The mean chronological age of the experimental subjects was eight years five months, the standard deviation four months; the mean mental age was nine years four months, standard deviation one year; the mean I.Q. was 110.6, S.D. 13.0.

Experimental Task and Materials:

The basic task for this study, identical to that described in Chapter III, was to select one of two exemplars which matched the model according to a specific rule: number, color, size, or shape. A problem consisted of a set of six 35-mm. slides, for all of which the same concept applied. To solve each problem the child had to identify the appropriate rule. The object of the game was to find this rule in as few slides as possible.

Procedure:

All instruction and testing were carried out entirely by means of auto-instructional programs, using the equipment and materials described. Before the instruction began, all the children were given a pre-test to see how well they could perform the problem-solving task. Then followed six days of training, each session lasting approximately 15 minutes. Immediately after the training, a posttest was given; seven weeks later, a retention test was administered.

Experimental Treatments:

There were two strategy programs, Multiple Hypothesis Testing and Single Hypothesis Testing, each presented under two conditions of verbalization, Not-Speaking and Speaking, thus providing four experimental treatments.

Within each of the strategy treatments, the only difference between the speaking and not-speaking condition was that the speaking groups were required to say the selected hypothesis aloud, in addition to writing or making the correct response. For instance, where the not-speaking groups were told: "Choose a rule and write it in the proper box. Press the button that goes with this picture", the speaking groups were told: "Choose a rule and write it in the proper box. Say the rule. Press the button that goes with this picture." For the speaking condition, the voice-relay mechanism was adjusted so that if the child did not speak he could not receive a reinforcing light for his button-press response.

Memory Storage:

In the previous experiment, it had been observed that children had difficulty retaining negative feedback information so as to consistently reject incorrect solutions. To avoid this problem, children were supplied with booklets and pencils to serve as a memory aid.

In the Multiple Hypothesis treatment, the subjects were helped to focus on the two hypotheses associated with the correct exemplar on the first slide, and then to select one of these two on the basis of information provided with the second slide. Having thus attained the rule by the second slide, they should be able to select the correct exemplar for the remaining slides of the problem. For the Single Hypotheis group, the booklets helped remind each child which concepts were possible, and which ones had been tried and rejected, so that a non-replacement procedure could be adopted.

The booklets consisted of four different types of pages appropriate for the needs of each strategy group and each lesson. Figure 1 presents samples of the four page types, reduced in size. (The actual booklets were constructed by cutting regular manuscript paper into thirds, width-wise, so that each sheet was approximately three-and-a-half by eight-and-a-half inches.) The number and types of pages varied for each days' lesson, for each of the basic strategy treatments. Table 1 shows the composition of the booklets for both programs.

Hypothesis Testing Instruction:

On the first day of training, both strategy treatments received the same instructions and slides for the initial 25 items of the lesson. The first six slides taught the children how to operate the response panels; the next 10 slides presented the concept-identification task in terms of two concepts, color and shape.

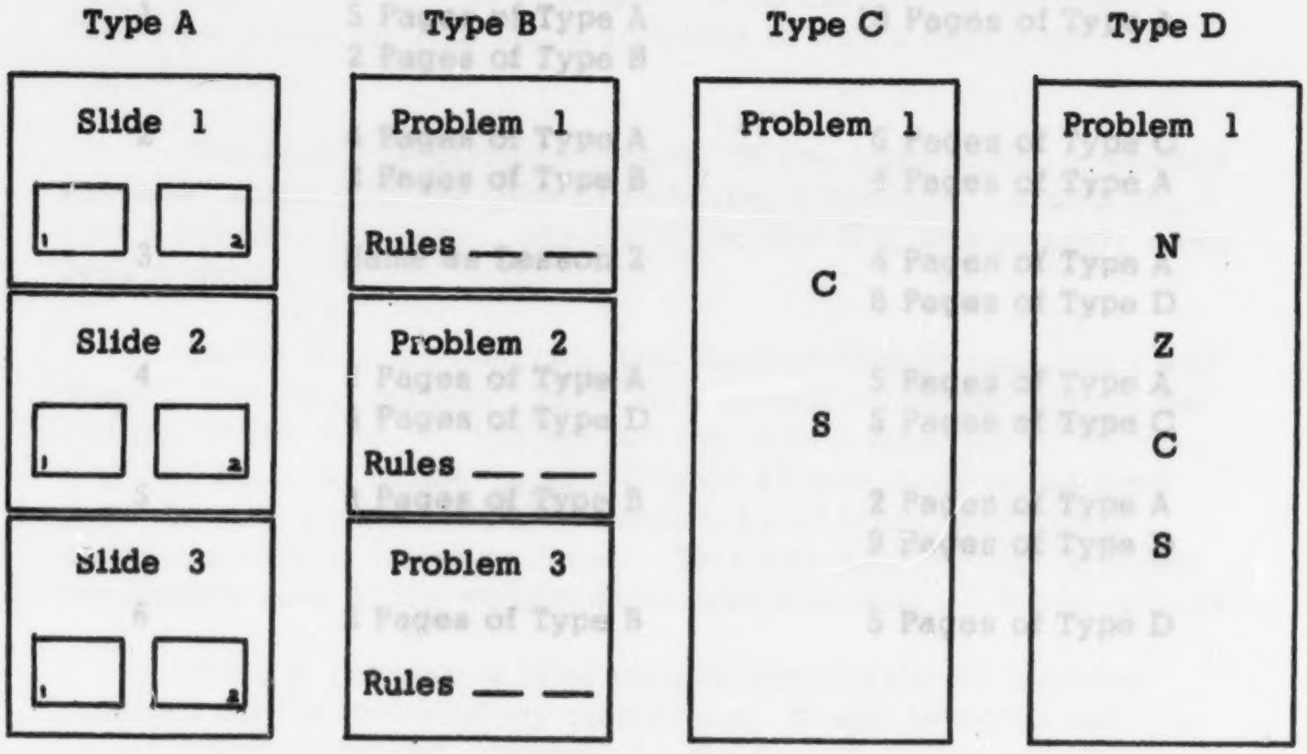
Type A
Type B
Type C
Type D
Slide 1
1
2
Slide 2
1
2
Slide 3
1
2
Problem 1
Rules
Problem 2
Rules
Problem 3
Rules
Problem 1
C
S
Problem 1
N
Z
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Figure 1. Sample Sheets from Booklets for Training Program

Table 1: Composition of Booklets Over Six Lessons

Lesson	Multiple Hypothesis Program	Single Hypothesis Program
1	5 Pages of Type A 2 Pages of Type B	10 Pages of Type A
2	4 Pages of Type A 2 Pages of Type B	6 Pages of Type C 4 Pages of Type A
3	Same as Lesson 2	4 Pages of Type A 8 Pages of Type D
4	2 Pages of Type A 4 Pages of Type D	5 Pages of Type A 5 Pages of Type C
5	3 Pages of Type B	2 Pages of Type A 9 Pages of Type D
6	2 Pages of Type B	5 Pages of Type D

The booklets were then distributed and the children were taught to write the first letter of the correct concept, as illustrated in nine slides, in the appropriate box on the Type A booklet page (see Figure 1).

The Multiple Hypothesis groups were then shown six slides in which one of the exemplars was the same as the model in both color and shape. As the first basic step in the Multiple Hypothesis testing procedure, the child had to write both of these rules in the appropriate box (on the Type A page) corresponding to the position of the exemplar on the screen. The children were then taught the second basic step in this strategy: to select the one correct concept from the two identified as associated with the correct exemplar. They were given six four-slide problems in which they used two Type B pages.

The Single Hypothesis groups, on the other hand, completed the first lesson with practice in selecting a concept, associating it with a specific exemplar, and testing to see if it was correct, using Type A pages.

In the first lesson, only two concepts were used, color and shape. The third concept, size, was introduced on the second day and the fourth concept, number, on the third. After the fourth concept had been identified, a card (Figure 2) was hung on the front panel of each booth, listing the repertoire of rules from which problem solutions could be drawn. This was another way in which the memory load of the experimental task was reduced for all groups.

Table 2 presents a brief resume contrasting the training sessions for the two strategy conditions. It will be noted that the visual stimuli were not identical for the two programs, as they were in the first experiment. Wherever possible, the same slides and similar tasks were provided. On the fifth and sixth days of training, however, the slides and problems were identical for all treatment groups; only the strategy instructions varied.

Criterion Tests:

The posttest, given after the last day of training, consisted of nine six-slide problems, similar to the four-concept problems on which training had been given. Seven weeks later, the retention test, using these same slides in still another order, was administered.

Table 2: Content of Multiple and Single Hypothesis Training Programs

Multiple Hypothesis Program Activity	No. of Frames	Single Hypothesis Program Activity	No. of Frames
Lesson 1.		Lesson 1.	
Press for picture location	6	Press for picture location	6
Press for concept named	10	Press for concept named	10
Write S for shape or C for color in correct box	9	Write S for shape or C for color in correct box	21
Write both letters in correct box	6	Write appropriate letters, one in each box	9
Six 4-slide problems	24		
Total frames for Lesson 1	55		46
Lesson 2.			
Press for concept named	16	Press for concept named	17
Press and write Z for size	3	Press and write Z for size	3
Press and write 2 concepts in one box	9	Press and write named concept	9
Six 4-slide problems	24	Six 4-slide problems	24
Total frames for Lesson 2	52		53
Lesson 3.			
Press for concept named	16	Press for concept named	16
Write N for number	6	Write N for number	6
Write 2 rules in correct box	6	Write 2 rules in correct box	6
Six 4-slide problems	24	Eight 4-slide problems	32
Total frames for Lesson 3	[illegible]		60
Lesson 4.			
Press for concept named	16	Press for concept named	16
Write 2 rules in correct box	6	Write 2 rules in correct box	6
Eight 4-slide problems	32	Write concept named in box	18
Total frames for Lesson 4	54		56
Lesson 5.			
Press for concept named	12	Press for concept named	12
Nine 5-slide problems	45	Nine 5-slide problems	45
Total frames for Lesson 5	57		57
Lesson 6.			
Five 6-slide problems	30	Five 6-slide problems	30
Total Number of Frames	300		302

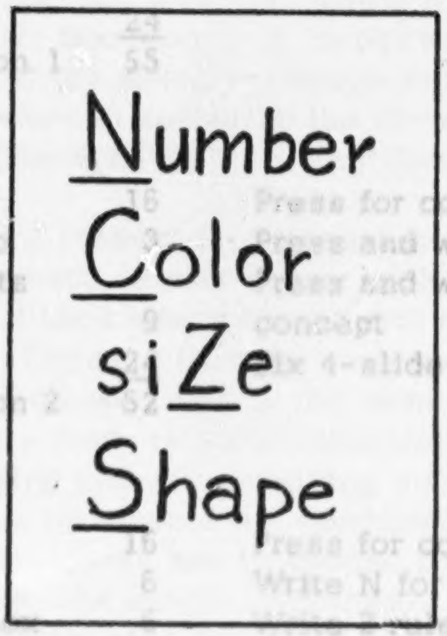

Figure 2. Rule Card.

Table 2: Content of Multiple and Single Hypothesis Training Programs

Multiple Hypothesis Program Activity	No. of Frames	Single Hypothesis Program Activity	No. of Frames
Lesson 1.		Lesson 1.	
Press for picture location	6	Press for picture location	6
Press for concept named	10	Press for concept named	10
Write S for shape or C for color in correct box	9	Write S for shape or C for color in correct box	21
Write both letters in correct box	6	Write appropriate letters, one in each box	9
Six 4-slide problems	24		
Total frames for Lesson 1	55		46
Lesson 2.			
Press for concept named	16	Press for concept named	17
Press and write Z for size	3	Press and write Z for size	3
Press and write 2 concepts in one box	9	Press and write named concept	9
Six 4-slide problems	24	Six 4-slide problems	24
Total frames for Lesson 2	52		53
Lesson 3.			
Press for concept named	16	Press for concept named	16
Write N for number	6	Write N for number	6
Write 2 rules in correct box	6	Write 2 rules in correct box	6
Six 4-slide problems	24	Eight 4-slide problems	32
Total frames for Lesson 3	52		60
Lesson 4.			
Press for concept named	16	Press for concept named	16
Write 2 rules in correct box	6	Write 2 rules in correct box	6
Eight 4-slide problems	32	Write concept named in box	19
Total frames for Lesson 4	54		56
Lesson 5.			
Press for concept named	12	Press for concept named	12
Nine 5-slide problems	45	Nine 5-slide problems	45
Total frames for Lesson 5	57		57
Lesson 6.			
Five 6-slide problems	30	Five 6-slide problems	30
Total Number of Frames	300		302

RESULTS

Performance During Training:

A question of primary concern in this study was whether the difficulty in learning the strategies was due to lack of understanding or excessive memory load. It is quite possible that the inadequate learning of either strategy in the previous study was due to inability to cope with memory storage and retrieval. That is, the children could not easily remember which concepts had been tested and rejected, and might wastefully replace and retest already disproved hypotheses. While the design of the present experiment was not intended to test this question directly, since it did not provide for booklet vs. no-booklet treatments, it is possible to gain some insight into the effect of the memory-storage system by noting how successful children were in selecting the correct exemplars for those problems where the concept rule was identified and recorded.

Figures 3 and 4 present as percentages, for Lessons 2, 4, and 6, the ratio of correct selections per problem to the total number of slides in those problems where the correct rule was written down. It can be observed in Figure 3 that the performance of the speaking and the non-speaking groups, within the same treatment, appears quite similar, whereas there is some difference between treatments. In Figure 4 the speaking and non-speaking subgroups of the Multiple and Single Hypothesis treatments are combined. Here it can be seen that on Day 2, when subjects had to choose from three possible rules for each problem, the Single Hypothesis group seems to have followed its own correctly recorded rules with a higher percentage of success than the Multiple Hypothesis group.

The high initial success of the Single Hypothesis treatment is to be expected since the directions and problems were particularly simple at this point of the program.

On the 4th through 6th days, with a number of comparable four-concept problems, it may be noted, for the Multiple Hypothesis treatment, that the percentage of correct button-presses where the correct rule was recorded increased from 67% to 71%. For the same period, the Single Hypothesis group, facing the same type of problems, decreased from 76% to 72%. It is most likely that these figures are actually an underestimate of the extent to which the subjects were using their recorded cues, since the booklet information did not indicate at which slide the correct solution had been

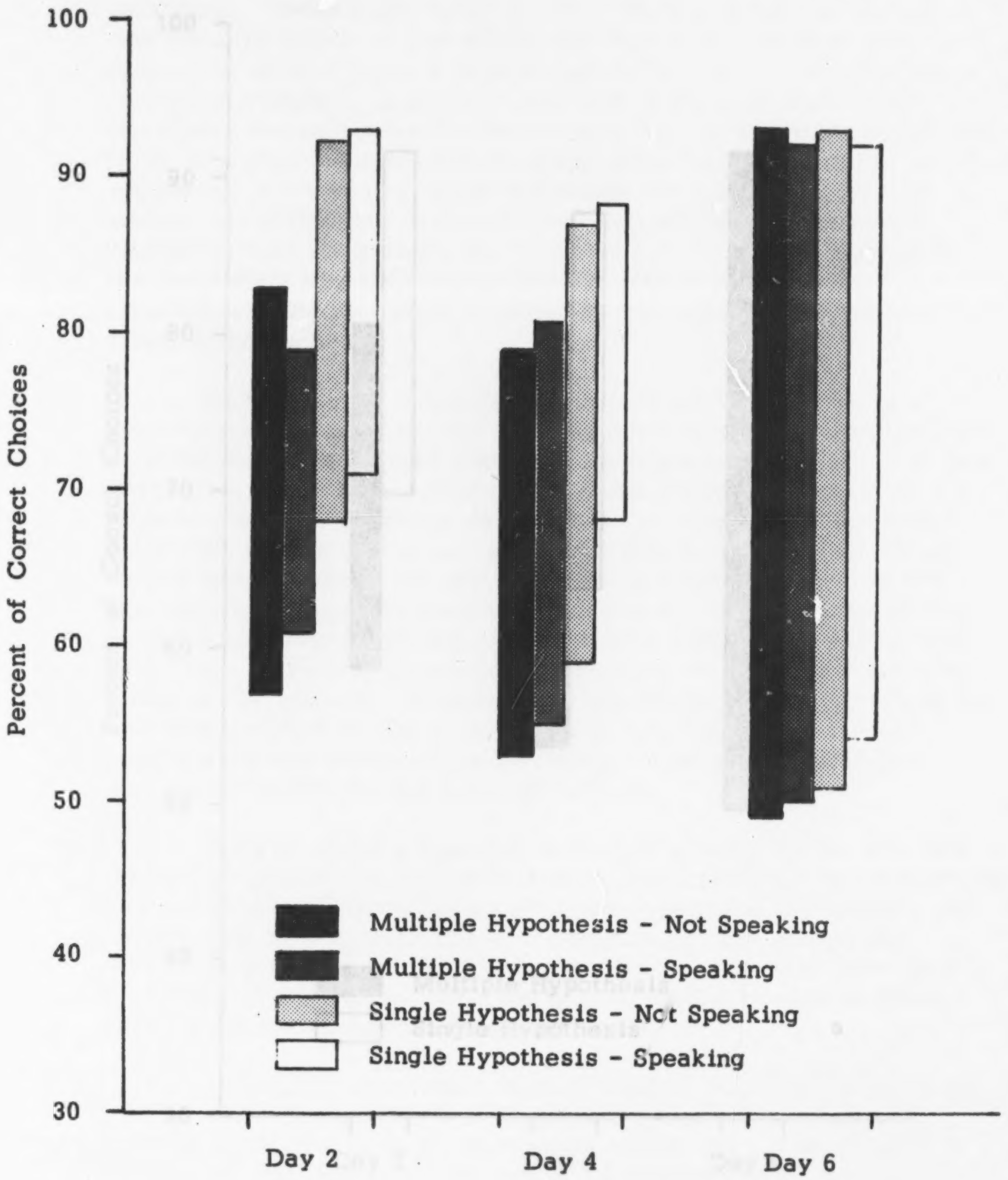

Figure 3. Percent of Correct Choices (M ± 1 SD) per Problem, when Correct Concept Written During 2nd, 4th, and 6th Day of Training, for Treatment Sub-groups.

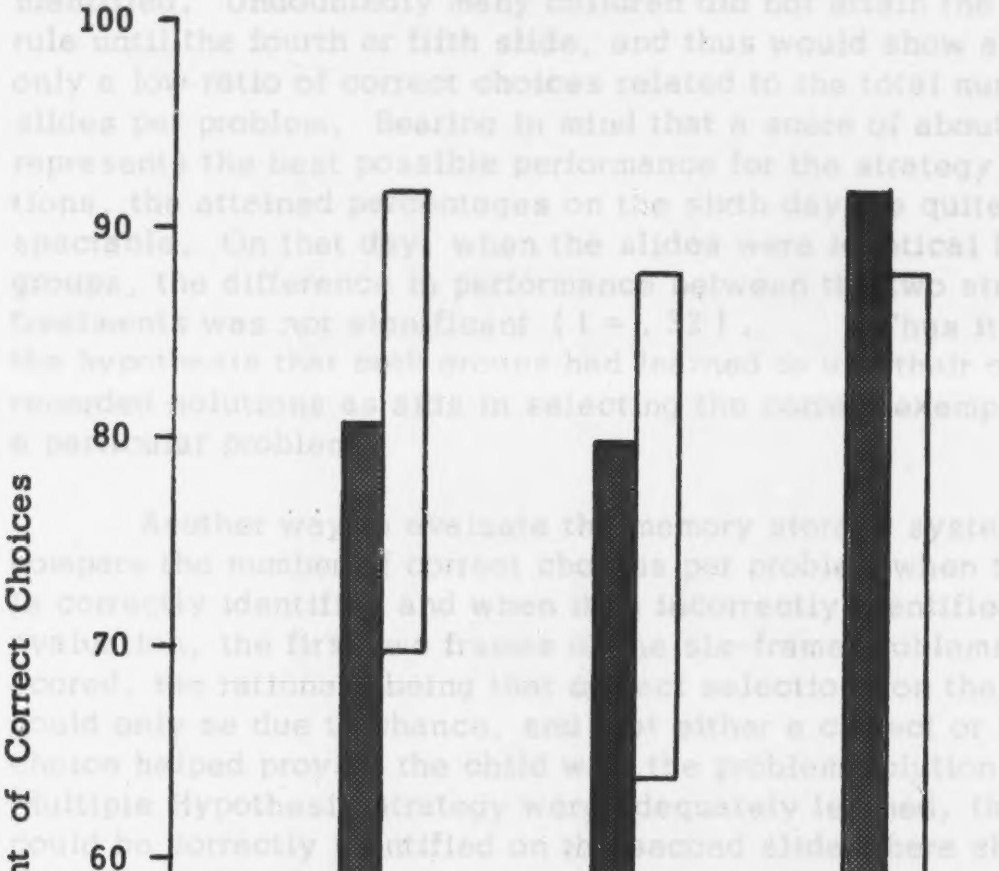

Figure 4. Percent of Correct Choices (M ± 1 SD) per Problem, when Correct Concept Written, During 2nd, 4th, and 6th Day of Training, for Treatment Groups.

identified. Undoubtedly many children did not attain the correct rule until the fourth or fifth slide, and thus would show at best only a low ratio of correct choices related to the total number of slides per problem. Bearing in mind that a score of about 80% represents the best possible performance for the strategy conditions, the attained percentages on the sixth day are quite respectable. On that day, when the slides were identical for both groups, the difference in performance between the two strategy treatments was not significant ($t = .32$). Thus it suggests the hypothesis that both groups had learned to use their own recorded solutions as aids in selecting the correct exemplars for a particular problem.

Another way to evaluate the memory storage system is to compare the number of correct choices per problem when the concept is correctly identified and when it is incorrectly identified. For this evaluation, the first two frames of the six-frame problems were not scored, the rationale being that correct selections on these slides could only be due to chance, and that either a correct or incorrect choice helped provide the child with the problem solution. If the Multiple Hypothesis strategy were adequately learned, the concept could be correctly identified on the second slide; there should then be no error in selecting the correct exemplar for the subsequent four slides of the problem. This scoring procedure definitely favored the Multiple Hypothesis group, since the Single Hypothesis strategy, even if perfectly executed, might purely on the basis of chance produce two errors on the four test frames.

In spite of these mathematical odds in favor of the Multiple Hypothesis procedure, the mean scores per problem for the last day of training (Table 3) provides no evidence to suggest that writing the correct rule for a problem leads to superior performance on that problem. However, for the Single Hypothesis treatment there was a significant difference (.001 level) between the number of correct choices per problem under these two conditions.

Although a comparison of mean number of correct presses per problem where the concepts were correctly identified reveals no reliable difference between treatments, there was a significant difference (.001 level) in the number of problems in which concept identification was attained. Out of a total of five problems, the MH treatment groups solved 68% while the SH group solved 88%; i.e., the Single Hypothesis group found the rule for an exceptionally high proportion of the problems.

Performance on Criterion Measures:

The means and standard deviations on all measures for the various treatment subgroups are presented in Tables 4 and 5.

Before any strategy training was instituted, all the children were given a problem-solving pretest to determine how well they could perform the experimental task before training. It can be seen from Table 4 that the scores on this two-choice task were at a chance level since the groups averaged approximately 10 points out of 20. Evidently without training of some kind the problem-solving task adopted for this project was too difficult for these children.

For each of the experimental groups, the importance of the gain made during training can be assessed in terms of the difference between the scores on the problem-solving pretest and the posttest. Here both of the within-treatment differences are significant ($t = 4.5$ and 9.4; $p < .01$ and .001 respectively). Furthermore, these gains were maintained intact for seven weeks as measured by the retention test. Although both groups were able to follow the taped instructions with approximately the same level of proficiency on the last day of training, only the Multiple Hypothesis group dropped significantly ($p < .01$) from training to posttest. The Single Hypothesis group seemed to have internalized the system they had been taught and could apply it just as well without prompts, whereas the Multiple Hypothesis group could perform the complex operations involved only when they were given instructional supports.

A 2 x 2 x 2 analysis of variance (Table 6) reveals no significant main or interaction effects attributable to verbalization on any of the dependent measures. That is, having the children name aloud the concept which they were going to use as a basis for matching seemed to have no reliable effect on training, posttest, or retention with either the Multiple or Single Hypothesis strategy conditions. Therefore, this variable was not used in comparing differences under the two treatment conditions.

The main effect of the treatments on the training scores was not reliable. However, the posttest, given immediately after the last day of training, showed significant treatment effects ($p < .01$). The Single Hypothesis group was clearly superior to the Multiple in solving these problems under test conditions where instructional supports were removed. On the retention test, no significant effects were found for treatment.

TABLE 3

MEAN NUMBER OF CORRECT SELECTIONS WHEN CONCEPTS WRITTEN CORRECTLY VS INCORRECTLY ON LAST DAY OF TRAINING (4 POSSIBLE)

	CONCEPTS WRITTEN CORRECTLY/INCORRECTLY				WITHIN TRTMNTS	
	M	SD	M	SD	T	P
MULTIPLE HYPOTHSIS	3.13	1.29	2.74	1.01	1.52	N S
SINGLE HYPOTHESIS	3.37	0.49	2.09	1.05	4.71	.001

MEAN NUMBER OF CONCEPTS WRITTEN CORRECTLY ON LAST DAY OF TRAINING (5 POSSIBLE)

	MULTIPLE		SINGLE		BETWEEN TRTMNTS	
	M	SD	M	SD	T	P
CORRECT CHOICE/CRRECT WRTTN	3.13	1.29	3.37	0.49	1.25	N S
CORRECT CONCEPTS WRITTEN	3.40	3.11	4.40	1.01	3.52	.001

Performance on Criterion Measures:

The means and standard deviations on all measures for the various treatment subgroups are presented in Tables 4 and 5.

Before any strategy training was instituted, all the children were given a problem-solving pretest to determine how well they could perform the experimental task before training. It can be seen from Table 4 that the scores on this two-choice task were at a chance level since the groups averaged approximately 10 points out of 20. Evidently without training of some kind the problem-solving task adopted for this project was too difficult for these children.

For each of the experimental groups, the importance of the gain made during training can be assessed in terms of the difference between the scores on the problem-solving pretest and the posttest. Here both of the within treatment differences are significant ($t = 4.5$ and 9.4; $p<.01$ and $.001$ respectively). Furthermore, these gains were maintained at least for seven weeks as measured by the retention test. Although both groups were able to follow the taped instructions with approximately the same level of proficiency on the last day of training, only the Multiple Hypothesis group dropped significantly ($p<.01$) from training to posttest. The Single Hypothesis group seemed to have internalized the system they had been taught and could apply it just as well without prompts, whereas the Multiple Hypothesis group could perform the complex operations involved only when they were given instructional supports.

A 2 x 2 x 2 analysis of variance (Table 6) reveals no significant main or interaction effects attributable to verbalization on any of the dependent measures. That is, having the children name aloud the concept which they were going to use as a basis for matching seemed to have no reliable effect on training, posttest, or retention with either the Multiple or Single Hypothesis strategy conditions. Therefore, this variable was not used in comparing differences under the two treatment conditions.

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TABLE 4

MEANS AND STANDARD DEVIATIONS ON INDEPENDENT VARIABLES WITH SUBGROUPS FOR TREATMENTS, MENTAL AGE, AND VERBALIZATION

TREATMENT			N	MENTAL AGE M	SD	CONCPT IDENTIF M	SD	PRBLM SOLV M	SD
MULTIPLE HYPTHSIS	NOT SPEAKING	HIGH	15	10- 3	0- 6	22.40	2.41	12.79	2.72
MULTIPLE HYPTHSIS	NOT SPEAKING	LOW	13	8- 7	0- 5	21.00	3.64	10.54	2.67
MULTIPLE HYPTHSIS	SPEAKING	HIGH	8	9-10	0- 3	19.38	6.19	10.43	1.99
MULTIPLE HYPTHSIS	SPEAKING	LOW	19	8- 7	0- 7	20.56	3.48	9.31	3.11
SINGLE HYPOTHESIS	NOT SPEAKING	HIGH	12	10- 8	1- 1	22.00	3.83	10.75	1.82
SINGLE HYPOTHESIS	NOT SPEAKING	LOW	14	8- 6	0- 7	23.00	0.88	8.54	2.33
SINGLE HYPOTHESIS	SPEAKING	HIGH	13	10- 0	0- 7	21.75	3.65	11.23	3.06
SINGLE HYPOTHESIS	SPEAKING	LOW	13	8- 8	0- 7	20.46	5.24	11.17	3.74
MULTIPLE HYPTHSIS	NOT SPEAKING	TTL	28	9- 6	1- 0	21.78	3.04	11.70	2.88
MULTIPLE HYPTHSIS	SPEAKING	TTL	27	8-11	0-10	20.19	4.39	9.65	2.82
SINGLE HYPOTHESIS	NOT SPEAKING	TTL	26	9- 6	1- 4	22.58	2.54	9.60	2.35
SINGLE HYPOTHESIS	SPEAKING	TTL	26	9- 4	0-11	21.08	4.50	11.20	3.33
MULTIPLE HYPTHSIS	TOTAL	HIGH	23	10- 1	0- 5	21.35	4.25	12.00	2.70
MULTIPLE HYPTHSIS	TOTAL	LOW	32	8- 7	0- 6	20.73	3.49	9.86	2.94
SINGLE HYPOTHESIS	TOTAL	HIGH	25	10- 4	0-11	21.86	3.64	11.00	2.50
SINGLE HYPOTHESIS	TOTAL	LOW	27	8- 7	0- 7	21.78	3.84	9.80	3.30
MULTIPLE HYPTHSIS	TOTAL		55	9- 2	0-11	21.00	3.81	10.76	3.00
SINGLE HYPOTHESIS	TOTAL		52	9- 5	1- 2	21.82	3.71	10.40	2.96

TABLE 5

MEANS AND STANDARD DEVIATIONS ON DEPENDENT VARIABLES WITH SUBGRJUPS FOR TREATMENTS, MENTAL AGE, AND VERBALIZATION

TREATMENT	N	TRAINING M	TRAINING SD	POSTTEST M	POSTTEST SD	RETENTN TST M	RETENTN TST SD
MULTIPLE HYPTHSIS NOT SPEAKING HI	15	17.36	2.31	15.00	3.37	15.80	3.17
MULTIPLE HYPTHSIS NOT SPEAKING LO	13	13.38	4.68	12.54	3.86	14.75	3.57
MULTIPLE HYPTHSIS SPEAKING HI	8	17.88	2.23	14.88	4.05	16.43	2.99
MULTIPLE HYPTHSIS SPEAKING LO	19	16.59	3.34	13.24	4.66	14.00	4.42
SINGLE HYPOTHESIS NOT SPEAKING HI	12	16.09	2.66	17.91	1.64	17.40	1.17
SINGLE HYPOTHESIS NOT SPEAKING LO	14	15.83	3.46	15.25	3.82	15.86	3.70
SINGLE HYPOTHESIS SPEAKING HI	13	15.92	2.81	16.08	3.06	15.00	2.83
SINGLE HYPOTHESIS SPEAKING LO	13	15.92	2.75	15.15	3.13	16.09	1.22
MULTIPLE HYPTHSIS NOT SPEAKNG TTL	28	15.44	4.11	13.81	3.76	15.33	3.33
MULTIPLE HYPTHSIS SPEAKNG TTL	27	17.00	3.04	13.76	4.46	14.71	4.14
SINGLE HYPOTHESIS NOT SPEAKNG TTL	26	15.96	3.04	16.52	3.22	16.50	2.98
SINGLE HYPOTHESIS SPEAKNG TTL	26	15.92	2.72	15.60	3.07	15.55	2.20
MULTIPLE HYPTHSIS TOTAL HIGH	23	17.55	2.24	14.95	3.54	16.00	3.06
MULTIPLE HYPTHSIS TOTAL LOW	32	15.20	4.22	12.93	4.27	14.31	4.04
SINGLE HYPOTHESIS TOTAL HIGH	25	16.00	2.68	16.96	2.60	16.14	2.48
SINGLE HYPOTHESIS TOTAL LOW	27	15.88	3.05	15.20	3.40	15.96	2.84
MULTIPLE HYPTHSIS TOTAL	55	16.19	3.68	13.79	4.07	15.04	3.71
SINGLE HYPOTHESIS TOTAL	52	15.94	2.85	16.04	3.14	16.04	2.65

As might be expected, mental age was found to have significant effects on both training and posttest. The effect was not found to be reliable on the retention test.

Table 7 presents a correlation matrix for six variables in which the coefficients have been separately computed for the Multiple and Single Hypothesis subjects. The obtained coefficients are, with only one exception, higher for the MH group than the SH group. The correlation between training and retention is significantly greater for the Multiple Hypothesis group than for the Single. This is in part attributable to the larger standard deviation, indicating that the MH treatment may have increased the variance among the subjects on this problem-solving skill. The obtained standard deviations on the training, posttest, and retention test are higher for the Multiple than for the corresponding ones for the Single Hypothesis strategy.

DISCUSSION

Although this experiment did not include a control group, comparing the problem solving pretest score to the training and posttest scores provides a measure of the effect of training. These results support the original hypothesis of the project that children can be taught strategies for solving a certain type of problem, and that they will then be better able to solve problems of the same class than children not given such training.

The first hypothesis of the present study, that the mathematically more effective strategy would prove superior to a simpler but potentially less effective one, was not supported. Although there was no reliable difference in performance between the two groups while the verbal instructions accompanied the problem presentation, on the posttest, where there were no strategy instructions, the scores of the Multiple Hypothesis group fell significantly below those of the Single Hypothesis group.

In the previous study, neither of the sequences had produced the level of performance which could theoretically be expected on the basis of the mathematical structure of the problems. A reanalysis of the two procedures revealed the fact that very different tasks were involved, and suggested that quite different instructional sequences were necessary. Since the objective was to teach both strategies to the maximum level of proficiency, whether or not the two programs were identical in content, or even in length, seemed to be quite

TABLE 6

ANALYSES OF VARIANCE ON DEPENDENT VARIABLES (TREATMENT X MENTAL AGE X VERBALIZATION)

	TRAINING				POSTTEST				RETENTION			
SOURCE	DF	MS	F	P	DF	MS	F	P	DF	MS	F	P
TREATMENT (A)	1	3.12	.31	NS	1	114.78	8.82	.01	1	16.11	1.54	NS
MENTAL AGE (B)	1	45.55	4.53	.05	1	88.70	6.82	.05	1	21.92	2.09	NS
VERBALIZATION (C)	1	19.84	1.97	NS	1	2.73	.21	NS	1	7.42	.71	NS
A X B	1	37.62	3.74	NS	1	.39	.03	NS	1	12.99	1.24	NS
A X C	1	21.73	2.16	NS	1	9.33	.72	NS	1	5.93	.57	NS
B X C	1	13.05	1.30	NS	1	9.76	.75	NS	1	2.23	.21	NS
A X B X C	1	8.80	.87	NS	1	1.24	.09	NS	1	22.84	2.18	NS
ERROR (WITHIN)	92	10.06			92	13.01			89	10.47		

TABLE 7

CORRELATION MATRIX

TREATMENTS	VARIABLES	CNCPT ID		PRBLM SOLV		TRAINING		POSTTEST		RETENTN	
		N	R	N	R	N	R	N	R	N	R
	MENTAL AGE										
MULTIPLE HYPTHSIS		53	.23	50	.28*	52	.38**	52	.36**	51	.35*
SINGLE HYPOTHESIS		49	-.14	50	.27	48	.02	48	.21	46	.11
	CONCEPT IDENTIF										
MULTIPLE HYPTHSIS				48	.32*	50	.35*	50	.20	51	.33*
SINGLE HYPOTHESIS				47	-.14	45	.10	45	.15	45	.01
	PROBLEM SOLVING										
MULTIPLE HYPTHSIS						48	-.02	48	.17	46	.08
SINGLE HYPOTHESIS						47	.18	47	-.06	44	-.10
	TRAINING										
MULTIPLE HYPTHSIS								52	.42**	48	.55**
SINGLE HYPOTHESIS								48	.04	42	.06
	POSTTEST										
MULTIPLE HYPTHSIS										48	.41**
SINGLE HYPOTHESIS										42	.10

*P < .05

**P < .01

irrelevant. For this reason, a great deal of time had been spent in program revision and development before initiating the present study.

The effect of this new program was most important for the Single Hypothesis strategy. The gain effected by the new Multiple Hypothesis training sequence while of the same dimension as that achieved by the Single Hypothesis group, was not sufficient to bring the former up to the same level of performance as the latter. While the increase in effectiveness was marked, the scores still fell short of expectations based on the mathematical probability inherent in the problems.

We may conclude, therefore, that the brighter children profited more from instruction in these strategies. The relative size of the correlation coefficients would suggest that this is probably more characteristic of the Multiple Hypothesis treatment. The inference might be drawn that the less capable subjects in the MH group had not yet achieved the stage of cognitive development requisite to mastering the complex strategy and that this might account for the relative inferiority of the Multiple Hypothesis group. These results might be reversed with children having higher mental ages, or with more effective programs.

CHAPTER V: THE THIRD EXPERIMENT

Acquisition of Problem Solving Strategies by Young Children and its Relation to Transfer

In the first two experiments, it was demonstrated that young children who were given instruction in certain hypothesis-testing strategies were better able to solve related problems than children without such training. However, neither of the programs used in the two studies succeeded in teaching the difficult Multiple Hypothesis testing strategy to the point of mastery. While it was true that for the Multiple Hypothesis treatment the revised program was more effective than the previous one, the new Single Hypothesis program was commensurately improved and the latter procedure continued to produce superior learning.

While the two new programs had been balanced in terms of sequencing, types of problems, and overall number of frames, there was no attempt to present exactly the same visual stimuli. Even so, the results demonstrated that to attain the objective of equivalent performance, the training used for the Multiple Hypothesis treatment would have to incorporate practice with techniques directly related to those used in the Multiple Hypothesis procedure. With this in mind, a new introduction to the basic MH strategy was devised, using entirely different pictures. Since no measurable differences attributable to overt verbalization had been established in the second study, labeling aloud the concepts used for matching was not required in the present design.

A consistent finding in both preceding studies had been the significant positive correlation between mental age and learning a complex strategy. To examine this relationship further, an elementary school with an unusually high mean I.Q. population was selected. In addition, it was felt that while the problem-solving pretest was adequate as a measure of performance without training, simple exposure to the task for the same period of time might, especially for bright children, produce as much improvement in performance as either type of training. Consequently, the new experiment included a control group given practice on the task without strategy instruction.

PROBLEM

In the present study, the relationship between mental age and strategy training was further explored, using a new program especially designed to improve the instruction of the Multiple Hypothesis procedure.

A 3 x 3 factorial design (three levels of MA and three treatments) was used to test the following hypotheses:

1) Children who are given instruction in either a Multiple or a Single Hypothesis testing strategy will be superior, as compared to a Practiced Control group given task experience alone, in (a) solving similar problems; (b) solving problems with new instances of the trained concepts; (c) generalization to new problems; and (d) retention of the trained material.

2) Children who have been taught the Multiple Hypothesis strategy will be more successful in these same four measures than either the Single Hypothesis group or the Practiced Control.

3) There will be an interaction between treatment and MA such that the difference in performance between the Multiple and Single Hypothesis groups will be related to levels of mental ability.

METHOD

Apparatus:

The UCLA Group Teaching Machine described in Chapter III was used for this study.

Subjects:

All the third grade children in a suburban elementary school in the Metroplitan Los Angeles area participated in this study. There were 132 children, 65 boys and 67 girls, with chronological ages ranging from seven years four months to 10 years; mental age from eight years to 14 years six months. The mean I.Q. of the total group was 123.2, S.D. 13.2.

Experimental Task and Materials:

The slides described in the previous chapters were used for the Single Hypothesis and Practiced Control groups. In addition, new materials were prepared for the Multiple Hypothesis training (Figure 1). These consisted of familiar objects such as a fish, a bird, a leaf, etc., in a different type of problem slide, but one in which the Multiple Hypothesis strategy was clearly applicable. Again, the task was to find the rule for the problem in as few slides as possible, using both negative and positive knowledge of results.

Memory Storage:

The booklet system described in Chapter III, adapted where required for the new Multiple Hypothesis program, was used. These booklets varied in number and types of pages, depending on the content of the daily lesson. After the four concepts had been introduced, a card listing all four possible rules for the problems was hung in each booth to reduce memory load. On the seventh day, fading of strategy instruction began. To compensate for the curtailed verbal commentary and to facilitate the child's internalization of the strategy instructions, the appropriate "System Card" (Figure 2) was placed in each booth during the final training sessions. The Practiced Control group did not, of course, receive this prompt.

Overview of Experimental Treatments:

I. Multiple Hypothesis Testing. The subjects in this group were taught to determine which was the correct exemplar and then to utilize knowledge of results both to identify the possible hypotheses and to eliminate those which were not possible. The most important feature of this strategy was that the child had to press a button first, before committing himself to a particular hypothesis. Only after the second slide, when the concept could be identified, was the child asked to locate the correct picture. This strategy permitted the child to halve the population of possible concepts with each of the first two slides, and arrive at the correct answer by the third.

II. Single Hypothesis Testing: The instructions here were to select a concept, test it, and continue to use it as long as positive results were obtained, but to switch to another hypothesis after negative feedback. Subjects were not taught to reject hypotheses associated with the negative exemplar by inspection; they rejected hypotheses only after they had been tested and found to be wrong.

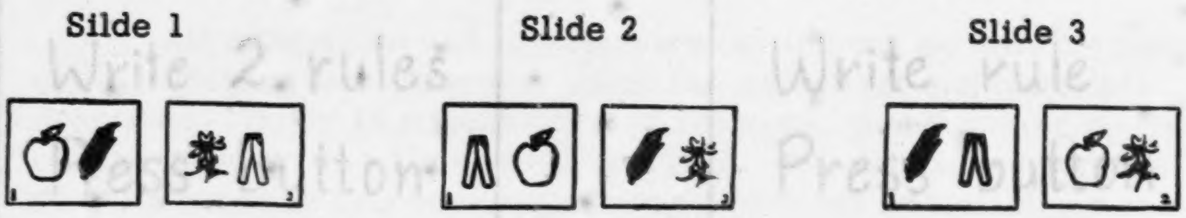
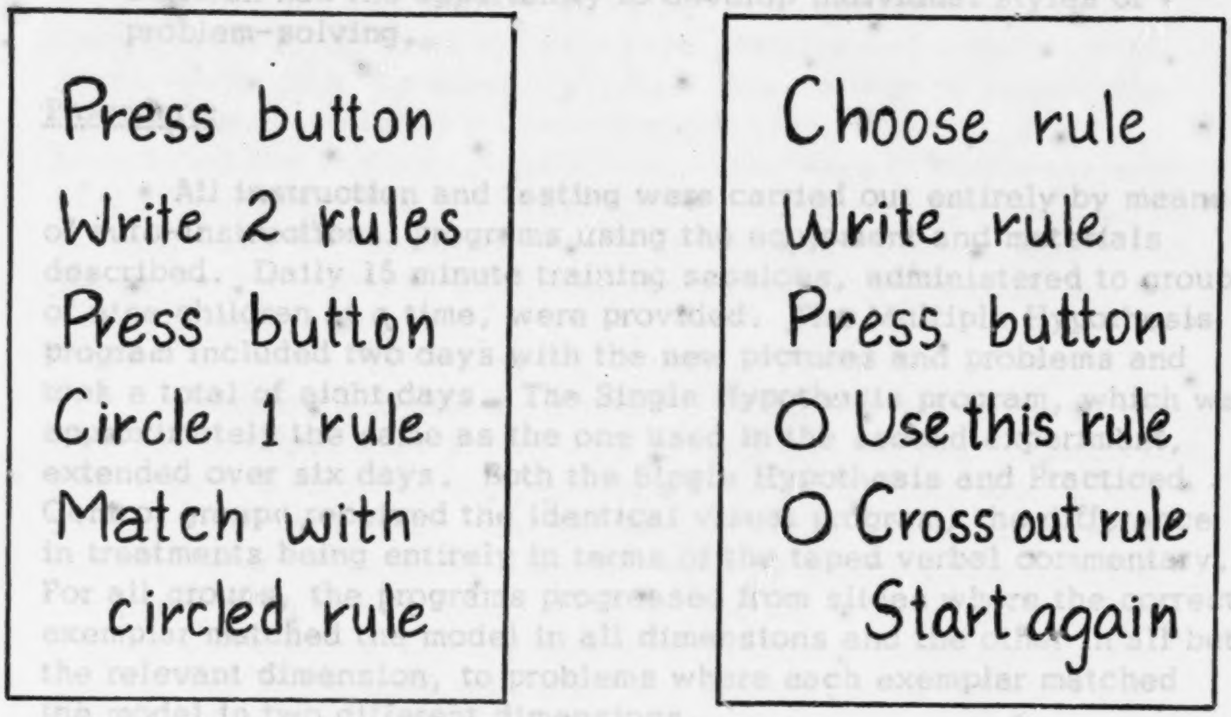

Slide 1
Slide 2
Slide 3

Figure 1. Sample of Slides used in the First Two Days of the Revised Multiple Hypothesis Program.



Press button
Write 2 rules
Press button
Circle 1 rule
Match with
circled rule

Choose rule
Write rule
Press button
O Use this rule
O Cross out rule
Start again

Multiple Hypothesis Strategy

Single Hypothesis Strategy

Figure 2. System Cards Providing Essential Steps in Strategy Procedures.

III. Practiced Control. Only task instructions and knowledge of results were given; subjects were presented with the problems and told to find the rule for matching. They were given the identical problems, slides, and booklets as the Single Hypothesis group, but without the strategy instructions. Presumably, these children had the opportunity to develop individual styles of problem-solving.

Procedure:

All instruction and testing were carried out entirely by means of auto-instructional programs using the equipment and materials described. Daily 15 minute training sessions, administered to groups of nine children at a time, were provided. The Multiple Hypothesis program included two days with the new pictures and problems and took a total of eight days. The Single Hypothesis program, which was approximately the same as the one used in the second experiment, extended over six days. Both the Single Hypothesis and Practiced Control groups received the identical visual program, the difference in treatments being entirely in terms of the taped verbal commentary. For all groups, the programs progressed from slides where the correct exemplar matched the model in all dimensions and the other in all but the relevant dimension, to problems where each exemplar matched the model in two different dimensions.

The slides used in the last three days of instruction were the same for all the treatment groups.

Strategy Instructions:

I. Multiple Hypothesis Strategy Procedure. After instruction in operating the response panels and interpreting the meaning of the light signals, the MH groups were given the booklets previously described.

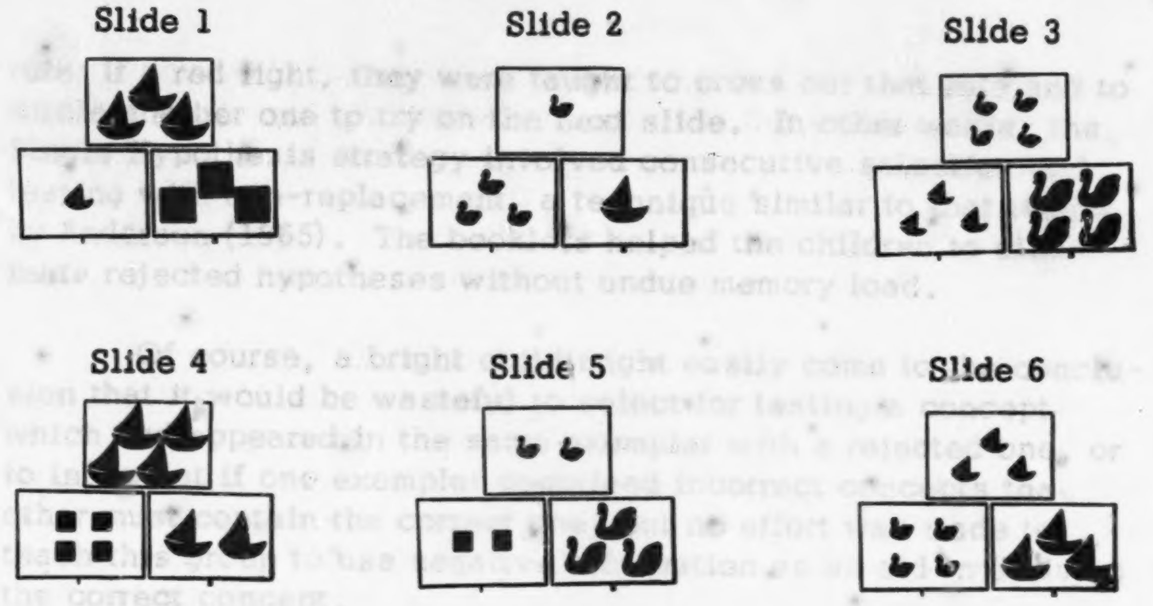
In the two previous studies it seemed that the children were having a great deal of difficulty in grasping the essence of the strategy, especially the necessity for obtaining information as to which was the positive and which was the negative exemplar, without commitment. The new slides, consisting of black and white line drawings of single objects (e.g., house, bird) were intended to teach the children to "ask questions" by pressing buttons which "fed back" information in terms of a red or green light.

Two pictures were presented, one in box 1 and the other in box 2. The task was to find out which was the correct picture by pressing a button. If a red light went on, it meant the picture corresponding to the button pressed was wrong, but the other picture was correct. This was confirmed by getting a green light for that picture. In this way, the children were taught to obtain information from both positive and negative feedback. Only after the green light was on were they to look at the slide. Now they could tell which picture was correct. After identifying the picture on the screen, they were to circle the word in the booklet for that picture. On the next slide, the same picture appeared and the task was to refer to the circled word, locate the corresponding picture, and press the button with the same number as the picture selected.

Practice was given with this very simple two-slide problem; then the children were shown a slide with two pictures in each box. Now they had to circle the two words which corresponded to the "green-light" exemplar. On the second slide, the pictures which had appeared in the same box were each in a different box. Again, the instruction was to press a button and get a green light before making a decision. Commitment to a particular rule as the correct answer was to be made only after the second button-press. The final problem required the children to find the correct picture when there were two pictures in each box on the test slides (Figure 3).

There were two days of this type of training, before the MH group was introduced to the number, color, shape, and size concepts which had been used in the previous studies. They then proceeded with approximately the same type of visual program as that of the Single Hypothesis and Practiced Control groups. However, the basic set of non-committal, of pressing a button first and then logically inferring the possible and non-possible concepts, continued to be the criterial feature of the program.

II. Single Hypothesis Strategy Procedure. The training for the SH group involved selecting a concept for testing, i.e., a commitment to a possible solution had to be made before either pressing a button or looking at the projected slide. The booklets for this group listed the entire repertoire of possible concepts, and the children were taught to circle the concept selected. The next step was to locate the exemplar which matched the model in the chosen dimension and to press the button for this exemplar. If a green light came on, they were to continue to use their circled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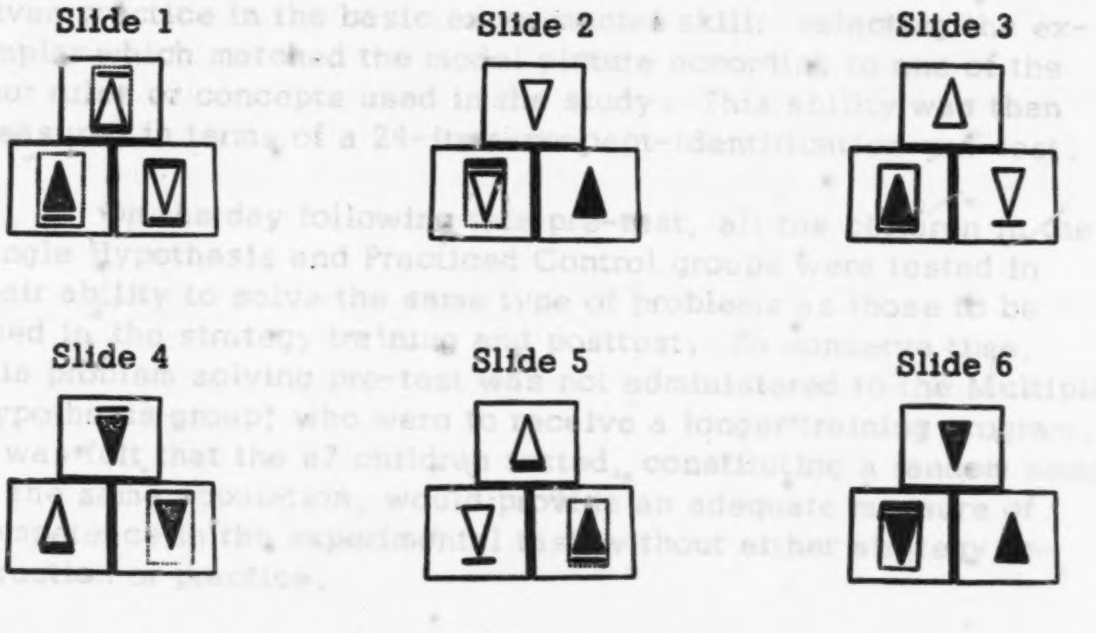
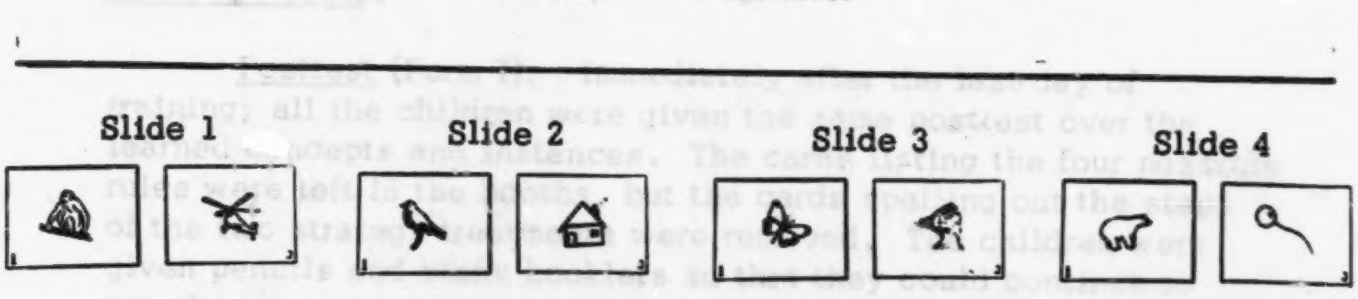
Near Transfer


Slide 1
Slide 2
Slide 3
Slide 4
Slide 5
Slide 6

Intermediate Transfer


Slide 1
Slide 2
Slide 3
Slide 4

Far Transfer

Figure 3. Sample Problems Used in Transfer Tests.

rule; if a red light, they were taught to cross out that rule and to circle another one to try on the next slide. In other words, the Single Hypothesis strategy involved consecutive selection and testing with non-replacement, a technique similar to that taught by Anderson (1965). The booklets helped the children to eliminate rejected hypotheses without undue memory load.

Of course, a bright child might easily come to the conclusion that it would be wasteful to select for testing a concept which had appeared in the same exemplar with a rejected one, or to infer that if one exemplar contained incorrect concepts the other must contain the correct one, but no effort was made to teach this group to use negative information as an aid in deriving the correct concept.

Pre-tests.

Before beginning the strategy training, all children were given practice in the basic experimental skill: selecting the exemplar which matched the model picture according to one of the four rules or concepts used in the study. This ability was then measured in terms of a 24-item-concept-identification pre-test.

On the day following this pre-test, all the children in the Single Hypothesis and Practiced Control groups were tested in their ability to solve the same type of problems as those to be used in the strategy training and posttest. To conserve time, this problem solving pre-test was not administered to the Multiple Hypothesis group, who were to receive a longer training program. It was felt that the 87 children tested, constituting a random sample of the same population, would provide an adequate measure of competence in the experimental task without either strategy instruction or practice.

Criterion Tests.

Posttest (Form I). Immediately after the last day of training, all the children were given the same posttest over the learned concepts and instances. The cards listing the four possible rules were left in the booths, but the cards spelling out the steps of the two strategy treatments were removed. The children were given pencils and blank booklets so that they could continue to use the memory storage systems they had been taught or had devised for themselves.

Transfer Tests. Following the test over the trained materials, three tests were administered to determine the extent of generalization over the continuum of transfer.

Transfer A. The first transfer test used the same concepts but different instances of shape and color.

Transfer B. Used the same type of problem slide (a model with two exemplars), a repertoire of four concepts, and contained six slides per problem. However, the pictures were black-and-white drawings of triangles which varied in interior design, direction of tip, presence or absence of bar and of border. A typical problem sequence is presented in Figure 3. The possible rules were listed on a card which was hung in the individual booths (Figure 4). If the Multiple Hypothesis strategy were used to solve these problems it was possible to attain the correct rule by the second slide.

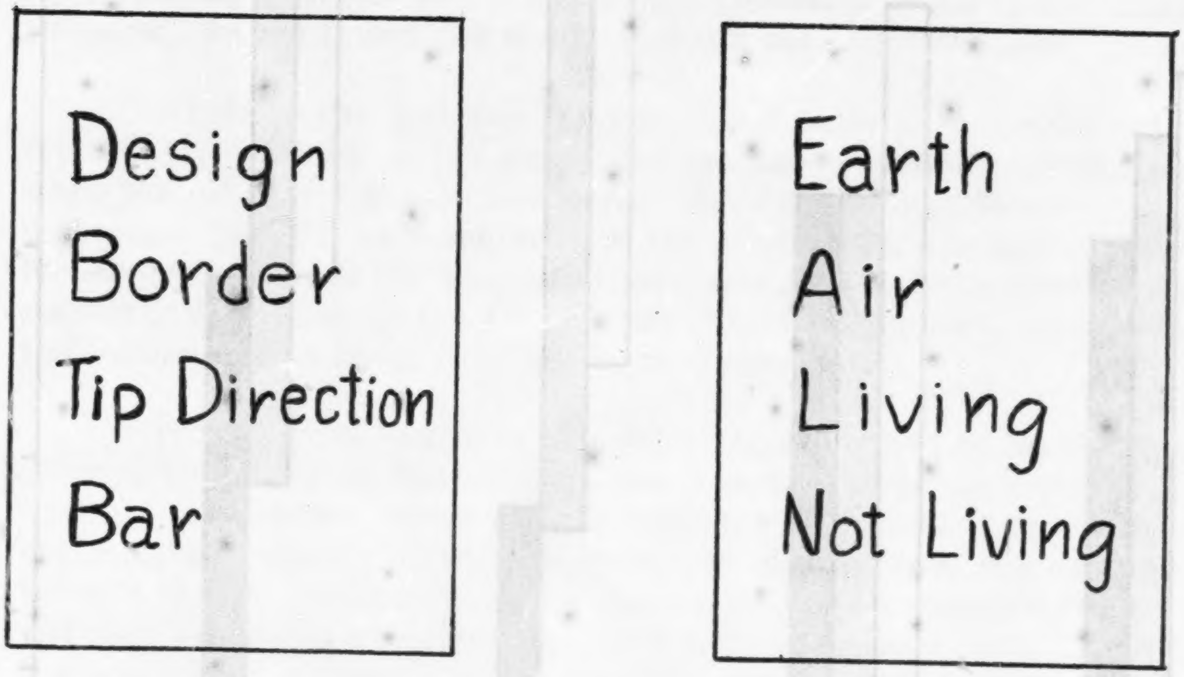
Transfer C. The problems in the last transfer test were quite different in content from those in the three preceding tests. The slides did not contain a model; instead, there were two pictures in each of two boxes (Figure 3), and there were four slides per problem. A list of possible concepts was also placed in the booths (Figure 4). Again, the Multiple Hypothesis strategy provided a technique for deriving the correct concept on the second slide.

Retention Test (Posttest, Form II). A month later, a retention test was administered. This test was a different form of the first posttest, using the same concepts and instances involved in the training program.

RESULTS

Performance During Training:

In the bar graphs (Figure 5) the means and standard deviations of percent of correct selections, when the concept was correctly recorded, to the total number of correct selections possible, are compared for the three groups for the second, fourth, sixth, and eighth day of training. It should be noted that while the Single Hypothesis and Practiced Control groups saw the same sets of slides throughout, the Multiple Hypothesis group worked with quite different visual stimuli on their second day of training. By the sixth day, however, all groups were solving the same sets of problems.



Design
Border
Tip Direction
Bar

Earth
Air
Living
Not Living

Rule Card for Transfer Test C

Rule Card for Transfer Test D

Figure 4. Cards Listing Repertoire of Concepts used in Transfer Tests.

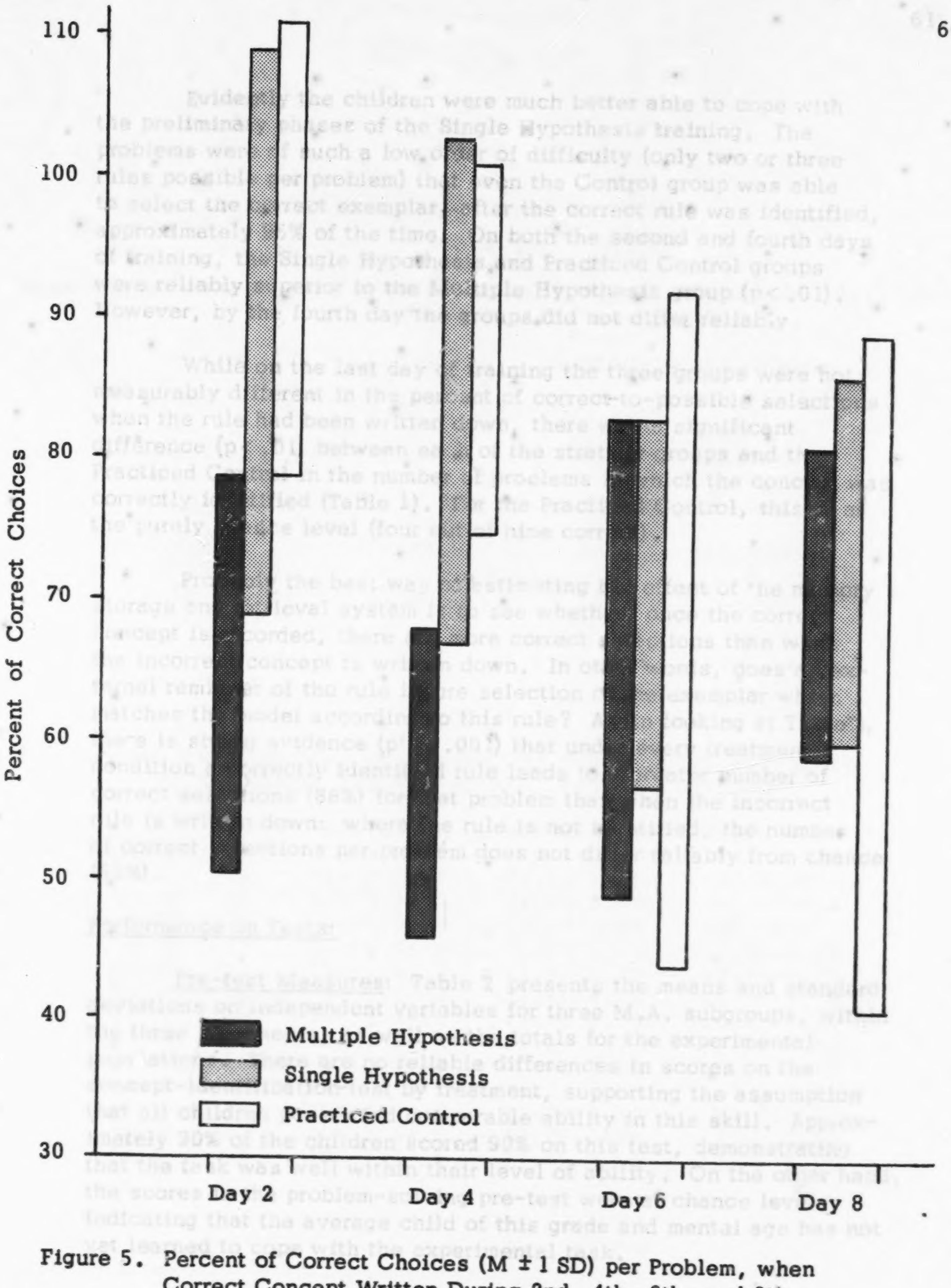


Figure 5. Percent of Correct Choices (M ± 1 SD) per Problem, when Correct Concept Written During 2nd, 4th, 6th, and 8th Day of Training, for Treatment Groups.

Evidently the children were much better able to cope with the preliminary phases of the Single Hypothesis training. The problems were of such a low order of difficulty (only two or three rules possible per problem) that even the Control group was able to select the correct exemplar, after the correct rule was identified, approximately 95% of the time. On both the second and fourth days of training, the Single Hypothesis and Practiced Control groups were reliably superior to the Multiple Hypothesis group ($p < .01$). However, by the fourth day the groups did not differ reliably.

While on the last day of training the three groups were not measurably different in the percent of correct-to-possible selections when the rule had been written down, there was a significant difference ($p < .01$) between each of the strategy groups and the Practiced Control in the number of problems in which the concept was correctly identified (Table 1). For the Practiced Control, this is at the purely chance level (four out of nine correct).

Probably the best way of estimating the effect of the memory storage and retrieval system is to see whether, once the correct concept is recorded, there are more correct selections than when the incorrect concept is written down. In other words, does an external reminder of the rule insure selection of the exemplar which matches the model according to this rule? Again looking at Table 1, there is strong evidence (p's $< .001$) that under every treatment condition a correctly identified rule leads to a greater number of correct selections (88%) for that problem than when the incorrect rule is written down: where the rule is not identified, the number of correct selections per problem does not differ reliably from chance (55%).

Performance on Tests:

Pre-test Measures: Table 2 presents the means and standard deviations on independent variables for three M.A. subgroups, within the three treatments, as well as the totals for the experimental populations. There are no reliable differences in scores on the concept-identification test by treatment, supporting the assumption that all children possessed comparable ability in this skill. Approximately 90% of the children scored 90% on this test, demonstrating that the task was well within their level of ability. On the other hand, the scores in the problem-solving pre-test were at chance levels, indicating that the average child of this grade and mental age has not yet learned to cope with the experimental task.

TABLE 1

MEAN NUMBER OF CONCEPTS WRITTEN CORRECTLY ON LAST DAY OF TRAINING (9 POSSIBLE)

MULTIPLE		SINGLE		BETWEEN TREATMNTS	
M	SD	M	SD	T	P
7.25	2.36	6.50	1.81	1.64	NS
MULTIPLE		**CONTROL**		**BETWEEN TREATMNTS**	
M	SD	M	SD	T	P
7.25	2.36	4.18	2.67	17.06	.001
SINGLE		**CONTROL**		**BETWEEN TREATMNTS**	
M	SD	M	SD	T	P
6.50	1.81	4.18	2.67	14.50	.001

TABLE 2

MEANS AND STANDARD DEVIATIONS ON INDEPENDENT VARIABLES BY TREATMENT AND MENTAL AGE FOR ALL SUBGROUPS

		MENTL AGE		CONCPT IDENTIF		PRBLM SOLV	
TREATMENT	N	M	SD	M	SD	M	SD
MH HI	15	11- 8	0- 7	22.64	1.65	NO PS-PT	
MH MD	13	10- 7	0- 3	22.00	1.68	NO PS-PT	
MH LO	15	9- 7	0- 6	19.57	3.13	NO PS-PT	
SH HI	14	11-10	0- 8	23.07	1.69	12.36	2.34
SH MD	11	10- 7	0- 2	21.81	2.86	13.54	3.75
SH LO	16	9- 6	0- 7	21.60	1.80	11.38	3.16
CT HI	16	11- 9	0-10	23.00	1.55	11.81	2.64
CT MD	12	10- 7	0- 3	22.27	1.79	13.00	3.57
CT LO	14	8-10	0- 6	20.42	3.00	12.43	3.69
MH T	45	10- 8	1- 0	21.45	2.60	NO PS-PT	
SH T	42	10- 7	1- 2	22.22	2.15	12.26	3.10
CT T	45	10- 5	1- 4	21.94	2.40	12.33	3.14

Criterion Measures: Table 3 presents the means and standard deviations on the dependent variables: training, posttest, transfer tests, and retention. Using the score on the problem-solving pre-test as a control measure, the Single Hypothesis group shows significant gain ($p < .01$) on both the training and the posttest. While the Practiced Control shows no measurable gains on the training test ($t = 1.3$), the additional practice provided on the last day of training seems to have had a decidedly facilitating effect, bringing the gain up sufficiently to produce a significant improvement at the .05 level ($t = 2.0$) on the posttest. It seems that these children, on the average, developed techniques for solving this type of problem so as to be significantly superior when compared to their own performance prior to this experience.

The graph (Figure 6) comparing the mean scores of the three treatments on pre-test, posttest, retention, and transfer highlights the differential effect of strategy vs no-strategy training. Figure 7, which presents the three transfer tests alone, demonstrates the consistency of the relationships among the Multiple, Single, and Control groups. However, for the intermediate and far transfer tests, the differences were not large enough to produce a significant F in an analysis of variance. Evidently, a greater variety of training materials would be needed to produce generalization of the problem-solving strategies to quite different problems. Also, the transfer problems seem to be of a higher order of difficulty, to judge by the low mean scores after experience with closely related problems, as compared to the scores on the pre-test over the materials used in training.

A 3 x 3 analysis of variance over treatment and mental age for all dependent variables is presented in Table 4. In addition, since the study was also interested in making comparisons between the two strategy treatments, aside from a Control group, a 2 x 3 analysis of variance is provided.

As could be expected from the fact that the Practiced Control was given no strategy instruction during the training test, there was a significant main effect for treatment ($p < .01$) on that measure when all three groups are considered. However, considering the two strategies alone, there is no significant main effect for treatment, indicating that, at least while the verbal supports were provided, both groups were able to follow the steps required at approximately the same level of efficiency (over 75%). While the 3 x 3 analysis showed no effect attributable to mental age on training, when the

TABLE 3

MEANS AND STANDARD DEVIATIONS ON DEPENDENT VARIABLES BY TREATMENT AND MENTAL AGE FOR ALL SUBGROUPS

		TRAINING		POSTTEST		RETENTION	
TRTMT	N	M	SD	M	SD	M	SD
MH HI	15	17.47	2.67	16.67	2.97	17.46	2.73
MH MD	13	15.38	3.88	14.08	3.06	14.69	3.07
MH LO	15	13.20	3.73	12.27	3.83	13.07	3.24
SH HI	14	16.33	3.20	15.43	2.65	15.43	2.93
SH MD	11	14.64	3.04	14.70	2.83	14.18	3.92
SH LO	16	15.06	2.89	15.13	2.78	14.38	3.05
CT HI	16	13.20	4.20	14.50	3.54	12.27	3.15
CT MD	12	12.42	3.73	14.92	3.23	13.55	3.36
CT LO	14	14.31	2.63	13.64	3.13	11.57	3.39
MH T	45	15.37	3.84	14.55	3.78	15.00	3.42
SH T	42	15.35	2.99	15.07	2.68	14.69	3.19
CT T	45	13.09	3.59	14.20	3.31	12.28	3.27

		TRANSFER A		TRANSFER B		TRANSFER C	
TRTMT	N	M	SD	M	SD	M	SD
MH HI	15	17.50	2.58	12.56	2.28	11.69	2.55
MH MD	13	13.83	5.04	11.79	2.91	11.86	1.99
MH LO	15	12.73	3.43	11.80	2.48	11.13	2.10
SH HI	14	14.71	3.43	12.79	2.89	10.57	2.28
SH MD	11	15.73	2.24	10.67	2.81	11.08	1.93
SH LO	16	13.25	3.21	11.56	3.22	12.00	1.75
CT HI	16	12.44	4.05	11.81	2.88	10.56	2.34
CT MD	12	12.93	3.37	10.60	2.80	10.33	2.32
CT LO	14	11.21	3.66	12.50	2.47	10.86	2.91
MH T	45	14.91	4.19	12.07	2.53	11.56	2.21
SH T	42	14.44	3.16	11.71	3.05	11.26	2.04
CT T	45	12.22	3.70	11.62	2.78	10.58	2.47

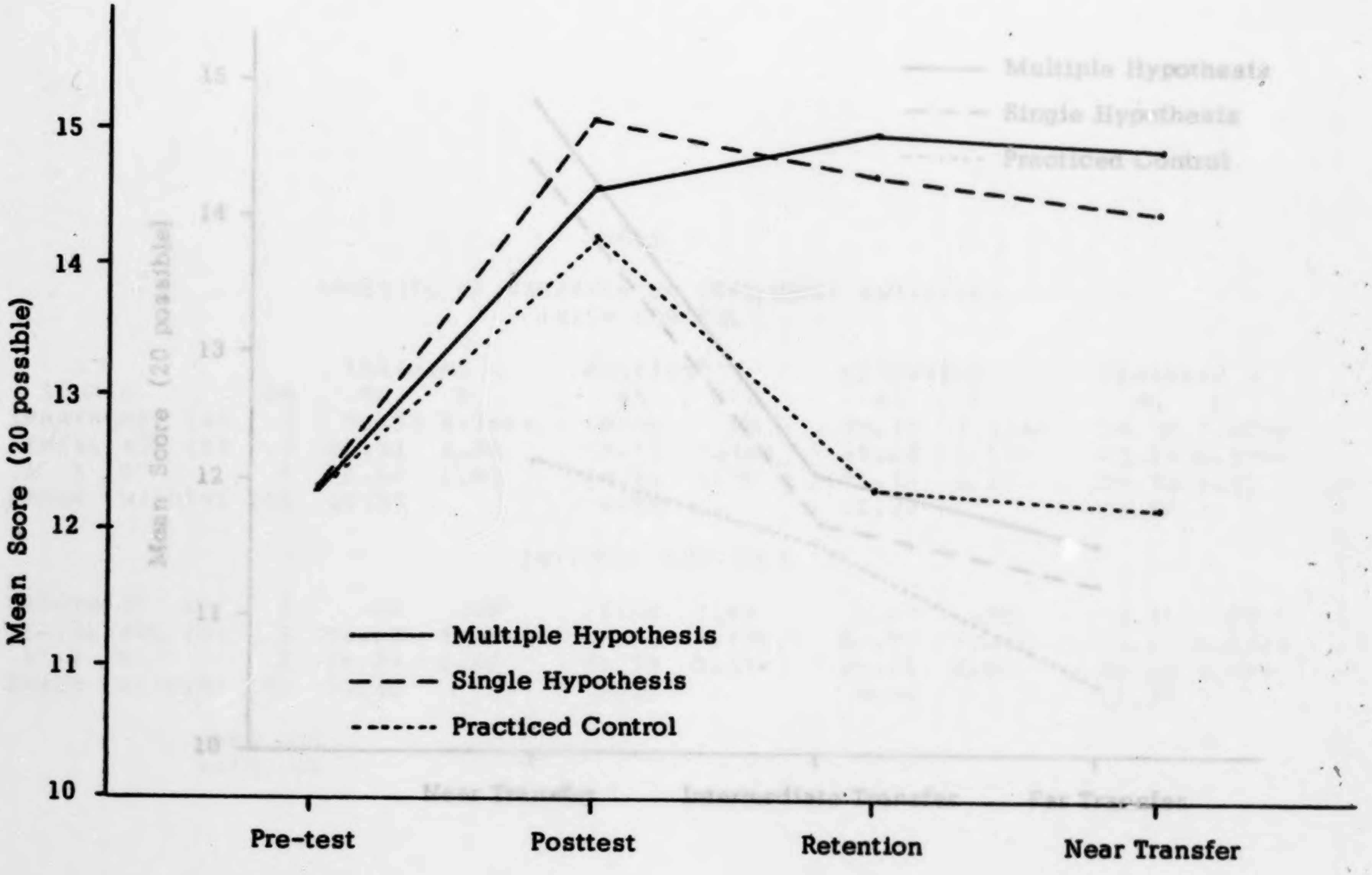


Figure 6. Mean Scores on Pre-test, Posttest, Retention, and Near Transfer, for Treatment Groups.

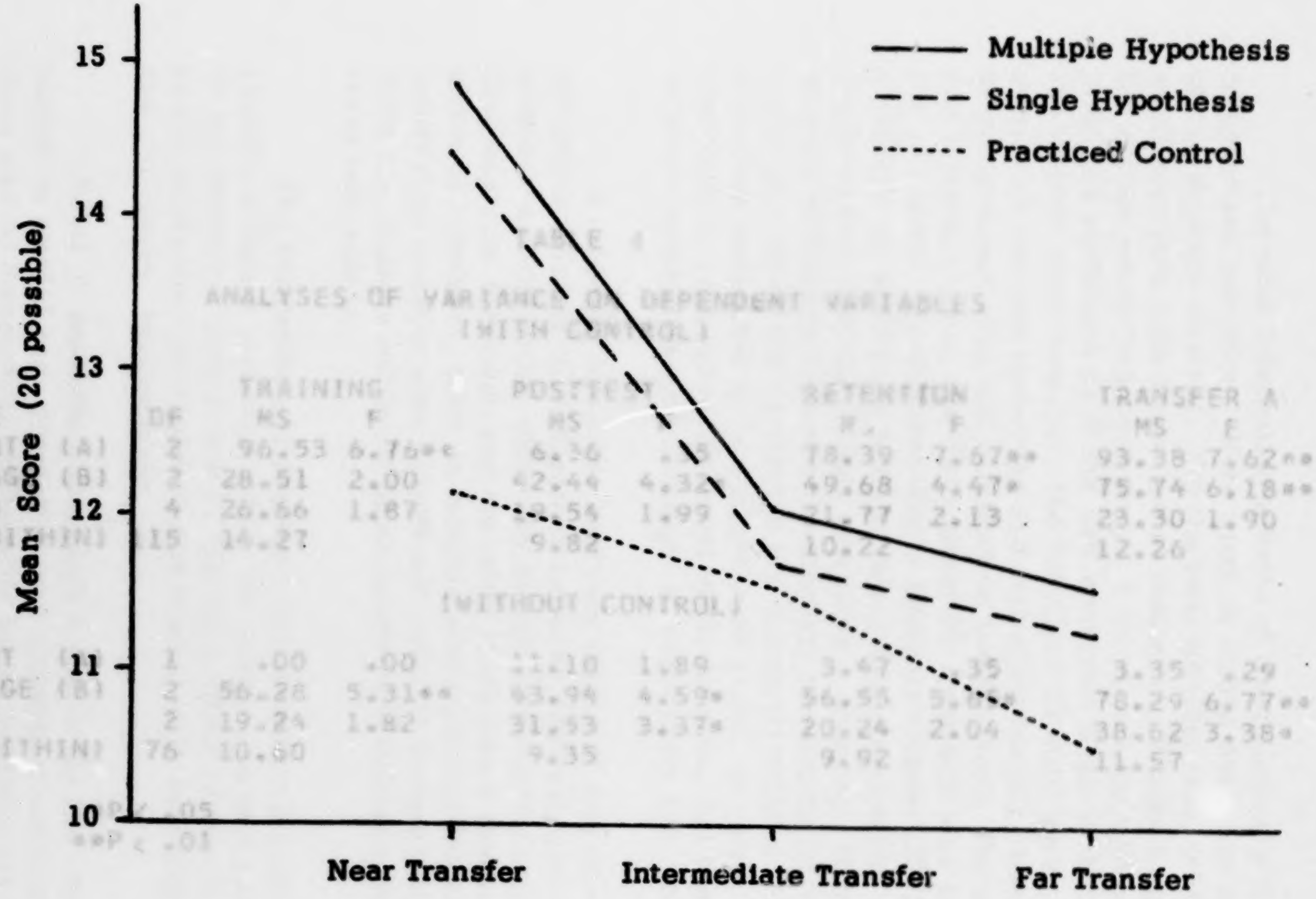


Figure 7. Mean Scores on all Transfer Tests for Treatment Groups.

two strategy treatments are compared there is a strong main effect (p< .01) for this variable.

The most interest[illegible] effects of [illegible]ents are those on transfer and retention [illegible] there is strong evidence of the value of the strategy training. On the near transfer test, which used the same concepts with [illegible] instances, Figure 6 shows that the groups which had been taught a procedure for solving these problems performed as if the new materials were no different from the trained ones; however, the Practiced Control were unable to cope with the new instances and fell significantly below the level of achievement they had [illegible] on the posttest. On both the transfer and retention tests, the main effect for treatment was significant at the .01 level. By Newman-Keuls analysis (Winer, 1962), there was a significant difference [illegible] between the two strategy groups and the Practiced Control on both measures; however, there was no reliable difference between the strategy treatments in the 3 x 3 analysis. When the strategies are compared without the control, a procedure necessary to test hypothesis three, the main effect of the treatment is still below the level of confidence, but the interaction between mental age and treatment is significant (p< .05).

A repeated measures analysis [illegible] was carried out to determine whether the differences between posttest-and-transfer and posttest-and-retention show any significant relationships. For the first analysis [illegible]ttest-and-transfer there was a dependable main effect of treatment, with no reliable evidence that the changes from posttest to transfer were significant over all the subjects; nor was there any reliable evidence of an interaction between treatments and these test scores.

The comparison of posttest-and-retention presents a slightly different picture. While the changes in test performance do not produce a significant F, the main effect of treatment as well as the interaction of treatment and measures is significant at the .05 and .01 levels, respectively.

Table 6 presents a correlation matrix for the three treatment groups on mental age, pre-tests, and dependent variables. While there was no measurable difference in the coefficients for M.A. and pre-test measures over the three groups on all the dependent variables there is an important difference among the coefficients for the Multiple Hypothesis and the other two treatments. As might be expected, all groups show significant correlations between the posttest, transfer, and retention measures.

TABLE 4

ANALYSES OF VARIANCE ON DEPENDENT VARIABLES

(WITH CONTROL)

SOURCE	DF	TRAINING MS	TRAINING F	POSTTEST MS	POSTTEST F	RETENTION MS	RETENTION F	TRANSFER A MS	TRANSFER A F
TREATMENT (A)	2	96.53	6.76**	6.36	.35	78.39	7.67**	93.38	7.62**
MENTAL AGE (B)	2	28.51	2.00	42.44	4.32*	49.68	4.47*	75.74	6.18**
A X B	4	26.66	1.87	19.54	1.99	21.77	2.13	23.30	1.90
ERROR (WITHIN)	115	14.27		9.82		10.22		12.26	

(WITHOUT CONTROL)

SOURCE	DF	TRAINING MS	TRAINING F	POSTTEST MS	POSTTEST F	RETENTION MS	RETENTION F	TRANSFER A MS	TRANSFER A F
TREATMENT (A)	1	.00	.00	11.10	1.89	3.47	.35	3.35	.29
MENTAL AGE (B)	2	56.28	5.31**	43.94	4.59*	56.55	5.65*	78.29	6.77**
A X B	2	19.24	1.82	31.53	3.37*	20.24	2.04	38.62	3.38*
ERROR (WITHIN)	76	10.60		9.35		9.92		11.57	

*P < .05
**P < .01

two strategy treatments are compared there is a strong main effect ($p < .01$) for this variable.

The most interesting effects of treatments are those on transfer and retention. Here there is strong evidence of the value of the strategy training. On the near transfer test, which used the same concepts with a new set of instances, Figure 6 shows that the groups which had been taught a procedure for solving these problems performed as if the new materials were no different from the trained ones; however, the Practiced Control were unable to cope with the new instances and fell significantly below the level of achievement they had attained on the posttest. On both the transfer and retention tests, the main effect for treatment was significant at the .01 level. By Newman-Keuls analysis (Winer, 1962), there was a significant difference (.01) between the two strategy groups and the Practiced Control on both measures. However, there was no reliable difference between the strategy treatments in the 3 x 3 analysis. When the strategies are compared without the control, a procedure necessary to test hypothesis three, the main effect of the treatment is still below the level of confidence, but the interaction between mental age and treatment is significant ($p < .05$).

A repeated measures analysis (Table 5) was carried out to determine whether the difference between posttest-and-transfer and posttest-and-retention show any significant relationships. For the first analysis (posttest-and-transfer) there was a dependable main effect of treatment, with no reliable evidence that the changes from posttest to transfer were significant over all the subjects; nor was there any reliable evidence of an interaction between treatments and these test scores.

The comparison of posttest-and-retention presents a slightly different picture. While the changes in test performance do not produce a significant F, the main effect of treatment as well as the interaction of treatment and measures is significant at the .05 and .01 levels, respectively.

Table 6 presents a correlation matrix for the three treatment groups on mental age, pre-tests, and dependent variables. While there was no measurable difference in the coefficients for M.A. and pre-test measures over the three groups, on all the dependent variables there is an important difference among the coefficients for the Multiple Hypothesis and the other two treatments. As might be expected, all groups show significant correlations between the posttest, transfer, and retention measures.

TABLE 5

ANALYSIS OF VARIANCE ON REPEATED MEASURES

SOURCE	DF	PSTTST + RETENTN MS	F	POSTTST + TRNSFR MS	F
TESTS (A)	1	19.27	3.13	37.60	7.14**
TREATMNTS (B)	2	55.66	3.47*	46.01	2.29
(A) X (B)	2	36.33	5.89**	29.53	5.61**
ERROR (BETWEEN)	117	16.02		20.12	
ERROR (WITHIN)	117	6.16		5.26	

*$p < .05$

**$p < .01$

TABLE 6

CORRELATION MATRIX

TREATMENT	VARIABLE	CNCPT ID N	CNCPT ID R	PRBLM SOLV N	PRBLM SOLV R	TRAINING N	TRAINING R	POSTTEST N	POSTTEST R	RETENTION N	RETENTION R	TRANSFER N	TRANSFER R
	MENTAL AGE												
MULTIPLE HYPTHSIS		41	.44**	NO DATA		42	.46**	43	.48**	42	.46**	43	.45**
SINGLE HYPOTHESIS		40	.27	41	.16	39	.17	40	-.10	41	.11	40	.29
PRACTICED CONTROL		35	.46*	43	-.03	41	-.14	43	.04	41	.08	43	.14
	CONCEPT IDENTIFICATION												
MULTIPLE HYPTHSIS				NO DATA		41	.53**	41	.63**	40	.36*	41	.44**
SINGLE HYPOTHESIS				41	-.06	39	.63**	40	.37	41	.23	40	.22
PRACTICED CONTROL				36	.20	36	.02	36	.17	36	.31	36	.24
	PROBLEM SOLVING												
MULTIPLE HYPTHSIS						NO DATA		NO DATA		NO DATA		NO DATA	
SINGLE HYPOTHESIS						40	-.07	41	-.06	42	-.08	41	.12
PRACTICED CONTROL						43	.03	45	.04	43	.19	45	.12
	TRAINING												
MULTIPLE HYPTHSIS								42	.69**	41	.69**	42	.73**
SINGLE HYPOTHESIS								39	.40*	40	-.06	39	.25
PRACTICED CONTROL								43	.37*	41	.36*	43	.46**
	POSTTEST												
MULTIPLE HYPTHSIS										42	.46**	44	.67**
SINGLE HYPOTHESIS										41	.30	41	.47**
PRACTICED CONTROL										43	.37*	45	.56**
	RETENTION												
MULTIPLE HYPTHSIS												42	.65**
SINGLE HYPOTHESIS												41	.45**
PRACTICED CONTROL												43	.57**

*P .05
**P .01

CONCLUSIONS

Support for the first hypothesis, that children who are given instruction in either of the problem-solving strategies will be superior to a practiced control group, was obtained with respect to solving similar problems, retention of trained materials, and transfer to similar problems with new instances (near transfer). However, there was no support for the prediction that there would also be differences in generalization to new problems.

Hypothesis two, that Multiple Hypothesis testing would produce superior problem-solving competency as compared with the Single Hypothesis procedure, was not substantiated on any of the four criterion measures.

The third hypothesis, which predicted interaction between mental age and treatment, was confirmed.

Thus this study has demonstrated that young children, through their own efforts, were able to arrive at a method for solving certain concept identification problems, showing a significant improvement (from 12.3 to 14.2) in performance from pre-test to posttest. They were not measurably inferior to the children who were given strategy instruction, who also demonstrated approximately the same increment in performance. However, on a transfer test which presented new instances of the same trained concepts, the unguided group showed a mean score of 12.2, which was not reliably different from the scores made on the comparable pre-test. The children who had received strategy instruction, on the other hand, showed no significant decrement from posttest to transfer test, and were significantly superior on this test than the controls. It may be inferred from these findings that the children who were given practice, without explication of the principles involved, were able to produce satisfactory solutions to the practiced problems but were unable to derive generalizable principles to help them in solving very similar problems.

On the retention test, which used only the material over which all children had received training, the Practiced Control group again showed significant decrement when compared to their performance on the posttest; the strategy trained groups showed no such loss, and the Multiple Hypothesis group actually showed a slight gain in raw score. Evidently the skill developed by the uninstructed children was of such a superficial nature that it was dissipated after approximately a month' s time. The strategy-instructed subjects maintained their gains over this period.

These data lend no support to the proposition that when children derive solutions to problems on their own without outside guidance, they are better able to retain what they have discovered and to utilize their learnings in new situations than if they are closely guided in the acquisition of an appropriate strategy.

Turning now to a comparison of the two strategies, a significant relationship was found between the Multiple Hypothesis strategy and mental age. Thus, the superiority of the Multiple Hypothesis testing strategy over the Single Hypothesis testing strategy was significantly greater for the higher mental age children than for the lower mental age children. For the more mature child in this study, the Multiple Hypothesis testing strategy was found to be more reliably effective than the Single Hypothesis procedure. The average child in the third grade is able to perform a "win-stay, lose-shift" type of technique, without replacement when memory storage is externalized, and performs as effectively as may be expected within the probability limits of this procedure. However, the child of average or above average ability does not readily internalize a procedure which relies on full use of knowledge of results. Even when the steps are spelled out, they do not seem to be able to profit from both negative and positive information so as to solve problems with the minimum necessary number of trials. While it is still quite plausible that a better, more carefully sequenced program may be devised to teach the procedure more effectively, so that even the average child may be able to internalize and to apply it without prompts, it is obviously not an easy strategy for these children to acquire.

CHAPTER VI: SUMMARY AND CONCLUSIONS

The series of experiments in this investigation was designed to study the value of teaching children certain information-processing skills, especially how to use knowledge of results in problem-solving. Young children may need to learn to benefit from a response which they are told is not appropriate without those feelings of frustration which are even at this early age associated with producing the wrong answer. Thus the child becomes accustomed to engaging in exploratory activities as part of the normal process of learning, without fear of being judged competent or incompetent as the result of what is really a question-asking trial. This approach would focus attention on the subject matter itself and avoid ego-involvement in exploratory responses which can only be correct or incorrect by chance. In this way extrinsic secondary reinforcements of teacher approval or disapproval may be considered subsidiary to the intrinsic reward of subject-matter mastery.

In a sense, this point of view is closely related to the role played by learning sets in Harlow's formulation. He has demonstrated that certain primates, who have through practice established appropriate information-processing learning sets, are able to reach criterion with one trial. They are able to do so because the feedback from the first response has become a discriminative stimulus, regardless of whether the first selection is correct or incorrect. For such experienced animals, therefore, knowledge of results on the first trial provides information rather than reinforcement.

The young children in the present investigation were taught to use certain information-processing strategies in solving problems. Contrary to the position expressed by Anderson (1965), the term "strategy" does not need to imply a mystical orientation. A problem-solving strategy may be behaviorally defined in terms of a set of instructional sequences designed to bring about a chain of responses to facilitate problem solving.

One of the two strategies taught the subjects in these experiments may be considered an information-getting procedure where the child was taught to interpret knowledge or results so as to reject more than one hypothesis at a time. In this Multiple Hypothesis testing strategy the children were taught to test hypotheses without commitment on the initial trials. The child, therefore, was taught to adopt an exploratory point of view, to obtain the necessary information in a systematic manner, before committing himself to any solution. In this strategy, therefore, knowledge of results was regarded purely as information and did not fulfill the function of reward. Finding out that a wrong choice had been made was not viewed by the child as an indication of failure; he was taught to learn just as much from the feedback regardless of whether he picked right or wrong alternatives on the two initial trials.

A second strategy, called the Single Hypothesis strategy, encouraged the learner to make a tentative commitment to a selection and to stay with it until proven wrong. This procedure, sometimes called the "win-stay, lose-shift" strategy frequently adopted by gamblers, did not stress knowledge of results as information. Instead, the child was taught to view his first guess as successful if it "worked" and a failure if it did not. The Single Hypothesis strategy was, therefore, a simpler procedure for the child to learn and adopt. He merely had to remember not to try a rule which he had previously found to be wrong for that problem.

In addition to comparing these two strategies, the series of experiments explored the value of each of these two instructional procedures as compared with a third: an opportunity for children to develop their own individual methods. This last group, the practiced control, were allowed to solve these problems with the same immediate knowledge of results, but were given no special strategy instructions.

PROBLEM

The central questions asked by the investigation were:

1. Will the information-getting Multiple Hypothesis testing strategy be learned and used by children more effectively than the Single Hypothesis testing strategy?

2. Will either of these procedures result in more effective performance than uninstructed but equivalent practice where children are left to develop their own strategies?

3. Will the more sophisticated Multiple Hypothesis strategy be more effective with children of higher mental age than with children of lower mental ability?

4. Will overt speaking or verbalization of the solution, or rule, help children in acquiring either of the two strategies?

METHOD

Apparatus:

The apparatus used in these studies was the UCLA Group Teaching Machine, which provides for the simultaneous instruction of ten children. Each child sat in a booth so that he could see the screen in front. The commentary was heard through the earphones as slides were projected on the screen. Each child responded by pressing a button to correspond with the picture of his choice. He received immediate knowledge of results by means of a red or green light to indicate whether he was correct. Microphones were used during the second experiment where the possibility of verbalization was explored.

The experimenter sat in the rear of the room to monitor the administration of the programs. The control center included a Kodak Carousel slide projector, a Wollensack tape recorder, and a Clary data punch to record the responses of the children. Through the use of a computer facility it was possible to take the punched tape and process it so as to obtain not only a printed summary of the programs of each child, but to provide the statistical analyses which were necessary.

Subjects:

For the first two experiments 110 and 108 children, respectively, were used. These children constituted the total third grade populations at two different Los Angeles City elementary schools. The mean mental ages of these samples were 109 months for the first and 112 for the second. This difference was partially due to the fact that the second experiment was conducted approximately two months after the first one. The third and last experiment involved a total of 132 third grade children in another school system within the Metropolitan Los Angeles area. The average mental age of this population was 127 months, which is fairly high for a third grade population.

Experimental Task:

The matching-to-sample problem chosen for this study involved discovering the rule for grouping two objects together into a single class. In order to provide a problem which the young child could reasonably be expected to solve without help, the children were given the four possible hypotheses; the task was to discover which one had been designated as the rule for each problem. A problem consisted of six slides on each of which there was a model picture in the top center and two exemplars below, one of which matched the model. There were four bases for matching: color, shape, number, and size. For each slide, the child had to select the picture which matched the model according to the rule for that problem. The child was informed immediately whether the choice was correct or not. The terminal problems were arranged so that one of the exemplars matched the model on two of the four bases while the other matched on the remaining two.

Young children of this age usually use no systematic method for attacking such problems. They will try hypotheses at random, frequently testing again hypotheses which they have earlier found to be wrong. The task thus appears to be appropriate for comparing different types of instruction in systematic problem solving.

Instructional Treatments:

I. Multiple Hypothesis Testing Strategy

In this strategy instruction the child was taught to postpone formulation of a solution until adequate information had been obtained. On the first trial in each problem, the child's response was aimed at finding out which exemplar was correct. He could then examine both exemplars to determine which two hypotheses to reject and which two were still viable. On the second trial, the child's response was again directed toward identifying the exemplar which contained the correct hypothesis. Regardless of which exemplar had been selected on the second trial, it was possible on the basis of the information obtained to "zero in" on the problem solution. By using this strategy, the child should have gained sufficient knowledge to enable him to obtain a perfect score on the last four trials of each problem.

This Multiple Hypothesis testing or information-processing strategy, therefore, has several features: 1) the child is taught to pay careful attention to the knowledge of results he receives on each trial; 2) he treats this feedback as useful information not as a reward for guessing correctly or a punishment for incorrect guessing; 3) by using the information supplied in two initial frames the child makes the most efficient decision at each point and, theoretically at least, solves the problem most quickly.

II. Single Hypothesis Testing Strategy

In the second strategy for this type of concept-identification problem, the child was taught a simple but systematic method of discovering the appropriate rule. He was simply instructed to try a rule and, if it worked, to continue using it; if the rule did not work the child was instructed to select and try another rule. Since he was also taught never to select a rule which had already been rejected, the strategy was one of non-replacement.

III. Practice without Instruction

In the first and third experiments, a third treatment group was included. These children were given the same orientation to the equipment and information regarding the nature of the task as the other groups. They were presented with the identical visual materials as the Single Hypothesis treatment. The only difference was that the Practiced Control subjects were not given any problem solving strategy instruction; instead, they were given the opportunity to develop their own information-processing systems.

Procedure:

An important feature in preparing the visual materials for all three groups was the use of a computer to generate sequences of instructional frames. The computer print-outs were arranged to guide the photographing of the slides for the final program. By this method not only was there a considerable saving in preparation time, but there was a high degree of confidence that an adequate sampling of available rules and instances were being presented. Randomness was also assured so that systematic programming errors would not allow the learner to be successful for the wrong reason.

For each of the experiments, children were brought in groups of ten to a regular classroom which had been set aside for this experiment. The daily lessons lasted from ten to twelve minutes and the total period of instruction and practice ranged from three to eight days in the different experiments. Approximately two to three additional days were required for the posttest.

Criterion Tests:

In all three experiments, an immediate posttest, with problems of the same type as used during training, was given to all subjects. In the second and third experiments, a second form of the immediate posttest was administered as a retention test eight weeks and three weeks later, respectively. In addition, on the third experiment three transfer tests, varying along the continuum of transfer, were presented.

RESULTS

In the first experiment three groups were used: a Multiple Hypothesis, a Single Hypothesis, and a Practiced Control. On the immediate posttest, the Single Hypothesis strategy proved to be significantly superior to each of the other two treatments. The Multiple Hypothesis testing strategy was not reliably superior to the Practiced Control. No interaction effects involving mental age were reliable, although a significant correlation between mental age and the Multiple Hypothesis strategy had been obtained.

In the second experiment, the two instructional strategy programs were compared, each with a verbalization and a non-verbalization condition; in this 2 x 2 factorial design no practiced control was used. For the first time a retention test was added. In this study the Single Hypothesis strategy was again found to be superior to the Multiple Hypothesis on the immediate posttest.

However, the difference between these two strategy instructions was not reliable on the retention test. There were no significant differences attributable to the factor of verbalization, suggesting that these children were too old for this variable to have an important effect.

In the third experiment the Multiple Hypothesis program was improved and expanded to eight daily lessons. With the final programs no reliable differences between the two strategies were obtained on any of the several criterion tests (immediate posttest, transfer, or retention) used for this experiment; the Multiple Hypothesis strategy instruction was no longer reliably different from the Single Hypothesis strategy.

Contrary to the results obtained in the first two experiments, the Practiced Control did not differ reliably from either strategy group on the immediate posttest. It seems likely that the greater mental maturity of the subjects in the third experiment enabled them, on their own, to discover some method of coping with the immediate problems. However, the mean score of this group was significantly below that of either of the strategy groups on the transfer test as well as the retention test given three weeks later. By using a repeated measures test, the decrement of the Practiced Control from the immediate posttest to each of the other two measures was found to be reliably greater than the comparable loss for the strategy groups. It would appear that children who learn some problem solving strategy on their own do not generalize or remember it as well as those children who have been systematically instructed to use a particular strategy.

The prediction that mental age would interact with the strategy treatments was supported in the last experiment, where the difference in performance between the high and low mental age groups was significantly greater for the Multiple Hypothesis strategy treatment than for the Single Hypothesis strategy treatment.

Additional light is thrown on this question by noting that the correlations between M. A. and posttest performance for the Multiple Hypothesis treatment were .41, .36, and .48 for the three experiments, respectively. On the other hand, the comparable correlations for the Single Hypothesis treatment were .15, .11, and -.10. The difference in correlations was consistent over the three experiments; on the last experiment the difference was statistically reliable. These results demonstrate that the effectiveness of the more difficult but presumably more efficient strategy was more closely related to the mental ability of the learner than was the simpler Single Hypothesis strategy.

CONCLUSIONS

A number of conclusions may be drawn from this series of experiments.

1. There was overwhelming evidence that instruction in problem-solving strategies involving the discovery of a rule was superior to the policy of providing children with an opportunity to practice and to formulate for themselves procedures without help. In the final experiment, this group of children sonehow learned to solve these problems at a level not reliably different from the other two groups. However, in comparison with the systematically instructed group, these "self-taught" children forgot reliably more during succeeding weeks. They also were less able to generalize whatever they had learned to new problems. This experiment, therefore, contradicts the popular notion that learning how to solve a class of problems on one's own is forgotten less rapidly and generalizes more widely than being carefully taught to adopt a systematic procedure.

2. The experiments demonstrated that in comparison with the simpler Single Hypothesis strategy, more capable children profited more from the Multiple Hypothesis strategy than did the less capable children. Individual differences in ability were more closely related to success with one instructional procedure than with the other.

3. The findings of this investigation may indicate that the curriculum of the primary grades should include, along with the necessary specific competencies, what might be considered a scientific attitude toward information getting and processing. Systematically encouraging the young child to ask questions and pose hypotheses on his own may prove to be a procedure in the cultivation of the young intellect which is not only desirable but possible.

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APPENDIX A

Abstracts of Two Pilot Studies

1. **Labeling and variety in concept identification with young children**
2. **Verbal cues and variety in concept identification learning of young children**

ABSTRACT

Labeling and Variety in Concept Identification with Young Children

Effects of labeling and variety were tested with 140 1st grade and 137 kindergarten children under automatically controlled experimental conditions. 6 treatment groups rehearsed either concept or instance labels using 8 concepts with 3 instances, 4 concepts with 6 instances, or 2 concepts with 12 instances. Kindergarten children rehearsing concept rather than instance labels received dependably superior scores in learning but not in transfer tests. 1st-grade children demonstrated both superior learning and transfer under concept-rehearsal conditions. Variety also produced significant differences at both age levels on learning tests. Intermediate variety (4 concepts) facilitated transfer to new instances and new concepts for older children. Results indicated the 2-concept, 12-instances condition to be least effective.

ABSTRACT

Verbal Cues and Variety in Concept Identification Learning of Young Children

40 Kindergarten children were randomly assigned among 4 treatment groups and taught to identify 2 concepts: animals and toys. The treatments were: 1) Label cued with 3 instances of each concept; 2) Label cued with 6 instances of each concept; 3) No label with 3 instances; and 4) No label with 6 instances. It was hypothesized and verified (.05 level) that cueing with appropriate concept labels would produce superior learning and transfer as compared with practice alone, without verbal cues. It was also hypothesized that cueing with several instances of each concept would provide superior learning and transfer as compared with few instances. While the evidence to support this hypothesis was not statistically significant, adjusted mean scores on all measures of learning and transfer indicated that, with cueing, higher mean scores were produced when 3 instances of each concept were used; in the uncued condition, 6 instances invariably produced higher scores.

APPENDIX B

The Computer Program

A Computer-Generated Sequence of Instructional Frames to Teach Problem-Solving Strategies to Young Children

With certain types of instructional programs, the writer of frames is frequently required to consider a wide range of criteria simultaneously. It seems inevitable that for tasks of this kind computers will become increasingly valuable in producing the desired sequences. The present paper reports the application of computer technology in generating an instructional program for an experimental investigation of young children's acquisition of strategies for solving concept-identification problems (Stern and Keislar, 1966).

For this study, it was necessary to randomly sample instances along several dimensions at the same time, under a number of critical constraints which were systematically removed during the course of instruction. The subject was presented with a 35 mm. slide containing three separate pictures: a model and two exemplars. Each picture consisted of from one to four different forms which could also vary in size and color; e.g., two large red stars, three small green circles, etc. The task was to discover, for each problem, the rule for matching an exemplar with a model. A problem consisted of four to six slides; for each slide the subject had to select, from two exemplars, the one which matched the model on the basis of the correct rule for that problem. There were four possible rules or bases for matching: number, size, color, and shape, with two levels or instances of size, and four instances each of the other three dimensions. With these materials it was possible to have 128 different combinations of dimension instances for any one picture.

The problem posed to the computer was to formulate sequences of three four-place numbers which would satisfy certain critical constraints necessary to produce a good instructional program, i.e., one in which there would be a gradual increase in problem difficulty consonant with the gradually-increased competence of the learner. The first step in the procedure was to randomly select one of the available dimensions to be the correct rule for a problem. Even though there are 128 combinations possible for any one picture, the next step, selecting the digits (representing specific instances) to describe the model, is not too difficult if a table of random numbers is used.

It is the multiplicity of ways in which the two exemplars can relate to the model and to each other which determines the difficulty level of a particular item within a problem. Since a slide consists of three individual picture descriptions, and each of these pictures has 128 possible variations or combinations of dimension instances, there are 128^3 possible slide permutations. A purely random selection of sequences of slide descriptions could not dependably produce a designated number of consecutive frames matched according to a predetermined rule. More important, however, it could not provide a specified number of successive problems of graded levels of difficulty without a set of complex relational restrictions. It is the necessity for maintaining the constraints required to produce a well-built instructional program which makes this a herculean task for a human programmer.

It has been noted that the critical feature of this particular instructional program involves the gradual increase in the difficulty of the problems. At the beginning it is necessary to have problems that are relatively easy to solve, while the terminal problems should be of maximum complexity. A logical analysis of the materials indicates that there are several variables which determine the difficulty level of a problem. These include:

1) The number of irrelevant dimensions in which the correct exemplar is like the model;

2) The number of irrelevant dimensions in which the incorrect exemplar is like the model;

3) The number of irrelevant dimensions in which the two exemplars are like each other;

4) The number of possible rules available for matching in each problem. In the beginning, the learner should be required to choose from only the two most easily discriminated rules (color and shape); at the end he must select the correct one from among all four possible rules.

The instructions to the computer, therefore, specify appropriate constraints, which may be modified after a given number of sequences of a specified type have been generated. In this way, the computer may be programmed to generate sets of problems of increasing complexity.

Within the constraints defined above, the computer may also be instructed to sample at random a wide variety of dimension instances, so that the learner will not be mislead by unintended regularities.

A simple type of computer output could be in terms of a listing of the three sets of four-digit numbers describing each of the slides in the program. However, converting these numbers into the combination of dimensional instances for photographing the slides permits too much opportunity for human errors in decoding. For this reason, the computer was instructed to translate the numeric code into words which would give a straightforward description of the composition of each slide.

While the program developed and reported here is specifically designed for use with the materials and content of the study cited, it can be easily adapted to a wide variety of applications, both in experimental research and in programmed instruction. For this reason, a brief description of the computer input and output is appended, and a printout of the source deck is available upon request.

COMPUTER INPUT:

System Cards*

Program Deck

The program deck spells out the instances of the various dimensions, which are translated into alphanumeric descriptions in the output. If different dimensions or different instances are desired, changes in the program deck will be necessary. However, if the same number of dimensions and instances of each are used, it is possible to adapt the output from the same deck by equating new dimensions or instances to the original ones. For instance, in constructing problems for the test of transfer to new instances of color and shape, instances 5, 6, 7, and 8 were substituted for 1, 2, 3, and 4 respectively, and problems generated by the same computer programs were used.

There are 10 output items for each problem. The first identifies one of four dimensions randomly selected as the relevant dimension for the problem, and indicates the problem number. The nine subsequent items describe the slides for that problem.

---

* All system cards are for a Fortran IV program on the 7094 Computer.

$ Data Card

Data Cards One for each set of problems of different level of difficulty or different types of ambiguities. Each data card must provide the following type of instruction:

Column

1 Level of problem difficulty.

1 = One relevant dimension only

2 = Two relevant dimensions, one for each exemplar

3 = Three relevant dimensions, randomly assigned to exemplars

4 = Four relevant dimensions, two for each exemplar

2 - 3 Number of problems of a specific level of difficulty to be generated.

4 - 12 Tables controlling three types of ambiguities for each of three non-relevant dimensions:

800 = Type 3 ambiguity: Both exemplars like model.
080 = Type 4 ambiguity: Both exemplars like each other; unlike model.
008 = Type 5 ambiguity: Both exemplars unlike each other and unlike model (except dimension 2 which has only two instances, and thus only Type 3 or 4 ambiguities are possible).
224 = Type 3, 4, or 5 ambiguity, designated at random (except no Type 5 for dimension 2).

13 1 indicates that all frames of a problem will have the same randomly-selected instance of each of the non-relevant dimensions. Blank indicates all instances are randomly selected from slide-to-slide within a problem.

14 - 17 Output options. These determine whether each new data card will continue the sequence of problems or begin a new sequence, within a specified level of difficulty. All blanks indicate that each data card controls its own output.

14 1 = Printout only.

15 1 = Punch and print additional output.

16 1 = Punch continuing set of cards, without printing.

17 1 = Continue sequence from preceding data card of same difficulty level.

Examples: 105800800800111 1

Level 1; 5 problems; all non-relevant dimensions of Type 3; non-relevant dimensions repeat instances on first slide for all slides of this problem; punched cards and printout requested; continue sequence of problems of same level.

310224224224111 1

Level 3; 10 problems; two non-relevant dimensions match model; non-matching non-relevant dimensions may be of Type 3, 4, or 5; whichever one is selected at random in first slide will hold for all slides of problem, and be the same instance as in the first slide; punched cards and printout requested; continue sequence.

2058000800801 1

Level 2; 5 problems; each exemplar like model in one (different) dimension. First non-relevant dimension has Type 3 ambiguity; second non-relevant dimension has Type 4 ambiguity; in a level 2 problem, the third non-relevant dimension will be like the model but not like the correct alternative; punched cards and printout requested; start new sequence.

COMPUTER OUTPUT:

Column

1 Problem difficulty level (described in computer input).

2 - 3 Problem number (within difficulty level).

4 Slide number (within problem).

5 - 8	**Type of correspondence or ambiguity for each of four dimensions (described in computer input).**
10	**Location of correct exemplar, per slide:** **1 = Left; 2 = Right.**
11	**Correct concept; 1 = Number; 2 = Size; 3 = Color; 4 = Shape.**
14 - 27	**Description of model.**
30 - 43	**Description of left exemplar.**
46 - 59	**Description of right exemplar.**
Example:	**4111221l 21 4 LGE BLK STAR 1 SML BLK STAR 4 LGE RED CIR**

This statement indicates a Level 4 problem; problem 11; slide 1; right exemplar like model in number and size; left exemplar like model in color and shape; right exemplar correct; number is correct concept; model is 4 large black stars; left exemplar is 1 small black star; right exemplar is 4 large red circles.

SOURCE DECK FOR GENERATING INSTRUCTIONAL FRAMES TO TEACH PROBLEM SOLVING STRATEGIES TO YOUNG CHILDREN

```
$DATE           32165
$IBFTC 2MU      DECK
       INTEGER NV(4)
          DATA (NV(I),I=1,4)/4,2,4,4/
       INTEGER ICD(4)
       INTEGER ITP,IPR(4),ISL
          DATA (IPR(I),I=1,4)/4*100/
       INTEGER ISK(3,3),IID(3),IICD(8,3)
       INTEGER VLFLG,OUT(4)
       LOGICAL NOPR,NOPU
       INTEGER DIM(4),SIZE(2),COLOR(4),SHAPE(4)
       DATA (DIM(I),I=1,4)/6HNUMBER,6HSIZE  ,6HCOLOR ,6HSHAPE /,
     -          (SIZE(I),I=1,2)/3HLGE,3HSML/,
     -          (COLOR(I),I=1,4)/3HRED,3HGRN,3HBLK,3HYEL/,
     -          (SHAPE(I),I=1,4)/4HCIR ,4HSTAR,4HDI  ,4HBEAN/
       INTEGER IVLT(4),IVLL(4),IVLR(4)
          EQUIVALENCE
     -    (IVLT1,IVLT(1)),(IVLT2,IVLT(2)),(IVLT3,IVLT(3)),(IVLT4,IVLT(4))
     -,   (IVLL1,IVLL(1)),(IVLL2,IVLL(2)),(IVLL3,IVLL(3)),(IVLL4,IVLL(4))
     -,   (IVLR1,IVLR(1)),(IVLR2,IVLR(2)),(IVLR3,IVLR(3)),(IVLR4,IVLR(4))
C
C      READ INPUT
C
 10    READ(5,1) ITP,NPROB,((ISK(I,J),I=1,3),J=1,3),VLFLG,(OUT(I),I=1,4)
 1     FORMAT(I1,I2,14I1)
C
C      OUTPUT HEADING
C
       WRITE(6,2) NPROB,ITP
 2     FORMAT('1',I3,' PROBLEMS OF TYPE 'I1)
       NINC=4-ITP
       NOPR=.TRUE.
       NOPU=.TRUE.
       IF(OUT(4).NE.0) GO TO 20
       NOPU=.FALSE.
       IF(OUT(3).NE.0) GO TO 20
       NOPR=.FALSE.
       IF(OUT(2).NE.0) GO TO 20
       NOPU=.TRUE.
       IF(OUT(1).NE.0) GO TO 20
       NOPR=.TRUE.
C
C      SETUP TABLES
C
```

```
   20  IF(NINC.EQ.0) GO TO 100
       DO 60 I=1,NINC
       K=0
       DO 60 J=1,3
       L=ISK(J,I)
       IF(L.EQ.0) GO TO 60
       DO 50 LL=1,L
       K=K+1
   50  IICD(K,I)=J+2
   60  CONTINUE
C
C      PROBLEM LOOP
C
  100  DO 800 IPROB=1,NPROB
       IPR(ITP)=IPR(ITP)+1
       DO 110 ID=1,4
  110  ICD(ID)=0
       JJD=JRANDM(RPAT,4)
       ICD(JJD)=-1
       IF(NINC.EQ.0) GO TO 150
           DO 130 I=1,NINC
  120      JD=JRANDM(RPAT,4)
           IF(ICD(JD).NE.0) GO TO 120
           ICD(JD)=3
  130      IID(I)=JD
  150  M=1
       DO 170 I=1,ITP
  160  JD=JRANDM(RPAT,4)
       IF(ICD(JD).GT.0) GO TO 160
       ICD(JD)=M
  170  M=3-M
C
C      OUTPUT PROBLEM CARD
C
       ISL=0
       IF(NOPR) GO TO 210
       WRITE(6,201) ITP,IPR(ITP),ISL,JJD,DIM(JJD)
  201  FORMAT('0',I1,I2,I1,6X,I1,1X,A6)
  210  IF(NOPU) GO TO 220
       WRITE(7,211) ITP,IPR(ITP),ISL,JJD,DIM(JJD)
  211  FORMAT(I1,I2,I1,6X,I1,1X,A6)
C
C      SLIDE LOOP
C
  220  DO 800 ISL=1,9
C
C   CHANGE 1 AND 2
C
       GO TO (310,330,350,370),ITP
C TYPE 1
  310  ICD(JJD)=3-JRANDM(RPAT,2)
       GO TO 390
```

```
C TYPE 2
 330  IF(JRANDM(RPAT,2).EQ.1) GO TO 390
      DO 340 ID=1,4
 340  IF(ICD(ID).LE.2) ICD(ID)=3-ICD(ID)
      GO TO 390
C TYPE 3
 350  ICD(JJD) =3-ICD(JJD)
      GO TO 330
C TYPE 4
 370  M=JRANDM(RPAT,4)
      IF(ICD(M).EQ.2) GO TO 370
 380  N=JRANDM(RPAT,4)
      IF(ICD(N).EQ.1) GO TO 380
      ICD(M)=2
      ICD(N)=1
      IF(JRANDM(RPAT,2).EQ.1) GO TO 390
      DO 385 ID=1,4
 385  ICD(ID)=3-ICD(ID)
C
C     SETUP CODES 3, 4, AND 5 FOR SLIDE
C
 390  IF(NINC.EQ.0) GO TO 405
      IF(VLFLG.NE.0.AND.ISL.GT.1) GO TO 405
      DO 400 I=1,NINC
      K=JRANDM(RPAT,8)
      L=IID(I)
      M=IICD(K,I)
      IF(L.EQ.2.AND.M.EQ.5) M=JRANDM(RPAT,2)+2
 400  ICD(L)=M
C
C FILL IN INSTANCES
C
 405  DO 500  ID=1,4
      K=ICD(ID)
      IF(VLFLG.NE.0.AND.ISL.GT.1) GO TO (410,430,500,500,500),K
      GO TO (410,430,450,470,490),K
C     CODE 1
 410  IVLT(ID)=JRANDM(RPAT,NV(ID))
      IVLL(ID)=IVLT(ID)
 420  IVLR(ID)=JRANDM(RPAT,NV(ID))
      IF(IVLR(ID).EQ.IVLT(ID)) GO TO 420
      GO TO 500
C     CODE 2
 430  IVLT(ID)=JRANDM(RPAT,NV(ID))
      IVLR(ID)=IVLT(ID)
 440  IVLL(ID)=JRANDM(RPAT,NV(ID))
      IF(IVLL(ID).EQ.IVLT(ID)) GO TO 440
      GO TO 500
C     CODE 3
 450  IVLT(ID)=JRANDM(RPAT,NV(ID))
      IVLL(ID)=IVLT(ID)
      IVLR(ID)=IVLT(ID)
      GO TO 500
```

```
C     CODE 4
  470 IVLT(ID)=JRANDM(RPAT,NV(ID))
  480 IVLL(ID)=JRANDM(RPAT,NV(ID))
      IF(IVLL(ID).EQ.IVLT(ID)) GO TO 480
      IVLR(ID)=IVLL(ID)
      GO TO 500
C     CODE 5
  490 IVLT(ID)=JRANDM(RPAT,NV(ID))
  494 IVLL(ID)=JRANDM(RPAT,NV(ID))
      IF(IVLL(ID).EQ.IVLT(ID)) GO TO 494
  496 IVLR(ID)=JRANDM(RPAT,NV(ID))
      IF(IVLR(ID).EQ.IVLT(ID).OR.IVLR(ID).EQ.IVLL(ID)) GO TO 496
  500 CONTINUE
C
C     OUTPUT SLIDE
C
      IVLT1=IVLT1
      IVLT2=IVLT2
      IVLT3=IVLT3
      IVLT4=IVLT4
      IVLL1=IVLL1
      IVLL2=IVLL2
      IVLL3=IVLL3
      IVLL4=IVLL4
      IVLR1=IVLR1
      IVLR2=IVLR2
      IVLR3=IVLR3
      IVLR4=IVLR4
      IF(NOPR) GO TO 530
      WRITE(6,501) ITP,IPR(ITP),ISL,(ICD(I),I=1,4),ICD(JJD),JJD,
     -IVLT1,SIZE(IVLT2),COLOR(IVLT3),SHAPE(IVLT4),
     -IVLL1,SIZE(IVLL2),COLOR(IVLL3),SHAPE(IVLL4),
     -IVLR1,SIZE(IVLR2),COLOR(IVLR3),SHAPE(IVLR4)
  501 FORMAT(1X,I1,I2,5I1,1X,2I1,3(2X,I1,1X,A3,1X,A3,1X,A4))
  530 IF(NOPU) GO TO 800
      WRITE(7,531) ITP,IPR(ITP),ISL,(ICD(I),I=1,4),ICD(JJD),JJD,
     -IVLT1,SIZE(IVLT2),COLOR(IVLT3),SHAPE(IVLT4),
     -IVLL1,SIZE(IVLL2),COLOR(IVLL3),SHAPE(IVLL4),
     -IVLR1,SIZE(IVLR2),COLOR(IVLR3),SHAPE(IVLR4)
  531 FORMAT(I1,I2,5I1,1X,2I1,3(2X,I1,1X,A3,1X,A3,1X,A4))
  800 CONTINUE
      GO TO 10
      END
```

Appendix C: The instructional programs

An Auto-instructional Program to Teach Young Children Two Strategies for Solving Concept Identification Problems

In the preceding section, a general rationale for the construction of an instructional program to teach young children certain strategies for solving concept-identification problems has been described. The various ramifications and complexities involved in writing the individual frames, and the value of a computer in performing this task, was also explored. Finally, the computer program designed to generate sequences of frames within certain sets of constraints was presented. In this section, the actual instructional programs, including both the numeric-code descriptions of every slide used, as well as the accompanying verbal commentary, are given in detail. For convenience and brevity, only the code descriptions of the pictures are reported. The numbers can be translated by reference to the following coding instructions:

1. An auto-instructional program to teach young children two strategies for solving concept identification problems

The basic materials of the program represent four dimensions or concepts: number, size, color, and shape, with several instances of each. Two sizes, large (1) and small (2); four colors, red (1), green (2), blue (3), and yellow (4); and four shapes, circle (1), star (2), diamond (3), and a free-form "bean" (4), are used.

The dimension itself is assigned a location in a four-place number. Thus each picture can be seperately described. For its mneumonic value, the locations follow the natural language sequence; for example, "one small yellow star" is certainly a more familiar structure than "star yellow one small". Hence, number is always the first place, size the second, color the third, and shape the fourth of the four-place number, and the code for "one small yellow star" is 1242. Three four-place numbers describe the three pictures on a problem slide.

Model-Exemplar Relationship

In addition to the numbers designating the dimension instances, a code was developed to describe the relationship between the model and each of the two exemplars, as well as the exemplars to

An Auto-instructional Program to Teach Young Children

Two Strategies for Solving Concept Identification Problems

In the preceding section, a general rationale for the construction of an instructional program to teach young children certain strategies for solving concept-identification problems has been described. The various ramifications and complexities involved in writing the individual frames, and the value of a computer in performing this task, was also explored. Finally, the computer program designed to generate sequences of frames within certain sets of constraints was presented. In this section, the actual instructional programs, including both the numeric-code descriptions of every slide used, as well as the accompanying verbal commentary, are given in detail. For convenience and brevity, only the code descriptions of the pictures are reported. The numbers can be translated by reference to the following coding instructions:

Picture Description:

The basic materials of the program represent four dimensions or concepts: number, size, color, and shape, with several instances of each. Two sizes, large (1) and small (2); four colors, red (1), green (2), blue (3), and yellow (4); and four shapes, circle (1), star (2), diamond (3), and a free-form "bean" (4), are used.

The dimension itself is assigned a location in a four-place number. Thus each picture can be separately described. For its mneumonic value, the locations follow the natural language sequence; for example, "one small yellow star" is certainly a more familiar structure than "star yellow one small". Hence, number is always the first place, size the second, color the third, and shape the fourth of the four-place number, and the code for "one small yellow star" is 1242. Three four-place numbers describe the three pictures on a problem slide.

Model-Exemplar Relationship:

In addition to the numbers designating the dimension instances, a code was developed to describe the relationship between the model and each of the two exemplars, as well as the exemplars to each other, for each of the four concepts. Thus "1" in any of the four dimension locations indicates that the lefthand exemplar (Exemplar 1) is like the model in that particular dimension, but the righthand exemplar is different from the model. A "2" indicates the reverse: the righthand exemplar (Exemplar 2) is like the model and the lefthand exemplar is not. A "3" indicates that all three pictures are alike (i.e., the same instance) for that dimension; "4" means that the two exemplars are like each other but unlike the model; and "5" signifies that all the pictures are different instances of the particular dimension. A type code of 2134 thus means that Exemplar 2 has the same number of designs as the model, but Exemplar 1 has a different number; Exemplar 1 is the same size as the model; all the pictures are the same color, and picture 1 and 2 are the same shape as each other but different from the model.

In the programs, four sets of four-place numbers represent every slide where a model and two exemplars appear. However, the first two days of the new Multiple Hypothesis training used pictures of familiar objects, with appropriate words to describe them, rather than numeric codes.

Criterion Tests:

While the posttest had the same dimensions and instances as the training program, the first transfer test used the same instances of size and number, but new instances of color: orange (5), purple (6), turquoise (7), and blue (8), and shape: swans (5), squares (6), boats (7), and cones (8).

The second transfer test moved to entirely new dimensions. Here, the pictures were all black-and-white drawings of triangles which varied in terms of interior design: none (1), stripe (2), or dots (3); direction of tip: up (1), down (2); presence or location of a bar: none (1), at tip (2), at base (3); and border: none (1), solid line (2), dotted line (3). Again, four sets of four numerals were used to describe each slide of a problem. All problems in the transfer test were of the 1122 type; that is, one exemplar was like the model in two dimensions and the other exemplar was like the model in the other two dimensions. Thus, while the picture content was quite different, the problems could be solved by applying the strategy taught in the training programs.

In the last set of transfer problems a new format was used. Instead of a model in the top center and two exemplars below, a problem slide consisted of only two boxes, in each of which there was a picture of a familiar object. Each picture contained a conjunctive concept and could be categorized in two ways: living or non-living; earth or air. Thus, an ape belonged to the living-earth class, a butterfly to the living-air class; a house was non-living-earth, an airplane non-living-air. The problems consisted of four slides in which the object was to determine the correct "rule". Again it was possible to use the strategies taught to test the hypotheses and select one which was appropriate for the particular problem. If the Multiple Hypothesis strategy were used efficiently, it was possible to arrive at the solution on the second slide. Thus, if a green light indicated that the ape was the correct exemplar, and the helicopter was incorrect, both the non-living and air categories could be eliminated. On the second slide, either a green or red light would determine whether the correct hypothesis was living or earth. If the green light appeared for the bird (or the red light for the house) the inference could be drawn that the correct hypothesis was "air".

For ease in describing the slides in this transfer test, the concepts are assigned a four-place number as follows: earth (first place), air (second place), living (third place), not-living (fourth place). Since each picture represents a conjunctive concept, any one picture has the same instance number in two different places.

Transfer Test C

Ape	1010	House	1001	Butterfly	0110	Helicopter	0101
Bear	2020	Train	2002	Parachutist	0220	Balloon	0202
Ram	3030	Slide	3003	Dragon fly	0330	Star	0303
Snake	4040	Car	4004	Hummingbird	0440	Kite	0404
Goat	5050	Truck	5005	Oriole	0550	Rocket	0505
Flower	6060	Skate	6006	Wren	0660	Plane	0606
Pig	7070	Toy	7007	Bluejay	0770	Zeppelin	0707
Tree	8080	Sled	8008	Eagle	0880	Arrow	0808
Carrot	9090	Shoe	9009	Robin	0990	Capsule	0909

All the slides and commentary for training and testing are described in the following pages.

2. The program for teaching the Multiple Hypothesis strategy

MULTIPLE HYPOTHESIS TRAINING

MH Lesson 1: Frame No.	Correct Concept	Commentary	Slide Description Ex. 1	Ex. 2	Correct Exemplar
1.		During the next few days you are going to learn to play a matching game. Like most games, you need to know the rules before you can play. First of all, you must learn to operate your equipment. Look at the little gray box in front of you. It is your control panel. There are five buttons, but the three buttons in the middle have caps over them. You are going to use only the button with the 1 under it and the button with the 2 under it. You can only press one of these buttons when your yellow light is on...like this...look at the screen.	(Blank)		
2.	fish	There is a picture of a pie in box 1 and a fish in box 2. Now I want you to choose the fish. The fish is in box 2, so you should press the button with the 2 under it, because button 2 on your panel goes with the picture in box 2 on the screen. Your yellow light is on, so you can press button 2...Take your finger off the button. You will see a green light in button 2. That means you have pressed the correct button.	(pie)	(fish)	2
3.	balloon	Now look at the screen. Here we have a balloon in box 1 and a coat in box 2. As soon as the yellow light goes on, press button 2 again. Now you got a red light. That means you didn't press the right button. But how could you? You had no way of knowing which was the correct picture. There will be many times in this game that you will be asked to press a button before you know the correct picture. The red light tells you that the picture we want is not in the box with the number you pressed. That means the other picture is the correct picture.	(balloon)	(coat)	1

MULTIPLE HYPOTHESIS TRAINING

MH Lesson 1.

Frame No.	Correct Concept	Commentary	Slide Description		Correct Exemplar
			Ex. 1	Ex. 2	
1.		During the next few days you are going to learn to play a matching game. Like most games, you need to know the rules before you can play. First of all, you must learn to operate your equipment. Look at the little gray box in front of you. It is your control panel. There are five buttons, but the three buttons in the middle have caps over them. You are going to use only the button with the 1 under it and the button with the 2 under it. You can only press one of these buttons when your yellow light is on...like this...look at the screen.	(Blank)		
2.	fish	There is a picture of a pie in box 1 and a fish in box 2. Now I want you to choose the fish. The fish is in box 2, so you should press the button with the 2 under it, because button 2 on your panel goes with the picture in box 2 on the screen. Your yellow light is on, so you can press button 2...Take your finger off the button. You will see a green light in button 2. That means you have pressed the correct button.	(pie)	(fish)	2
3.	balloon	Now look at the screen. Here we have a balloon in box 1 and a coat in box 2. As soon as the yellow light goes on, press button 2 again. Now you got a red light. That means you didn't press the right button. But how could you? You had no way of knowing which was the correct picture. There will be many times in this game that you will be asked to press a button before you know the correct picture. The red light tells you that the picture we want is not in the box with the number you pressed. That means the other picture is the correct picture.	(balloon)	(coat)	1

MH Lesson 1.

Frame No.	Correct Concept	Commentary	Slide Description Ex. 1	Slide Description Ex. 2	Correct Exemplar
		Put your finger on the red-light button. Press it down hard... Do that now...Put out the red light. Now press the other button and get a green light...The correct picture for this slide is the balloon.			
4.	leaf	Here's another slide. This time there is a leaf in box 1 and an airplane in box 2. Find the leaf and press the button with the same number as the box the leaf is in...If you get a red light, you pressed the wrong button. Put it out and get a green light. Try to get a green light the first time on the next slide.	(leaf)	(airplane)	1
5.	bird	Find the bird. Press the button with the same number...	(house)	(bird)	2
6.	rabbit	Find the rabbit...	(rabbit)	(cup)	1
7.	key	Press the button for the key...	(key)	(fan)	1
8.	bear	Press the button for the bear...	(bear)	(lion)	1
9.	bell	Now the bell...	(girl)	(bell)	2
10.	pipe	The pipe...	(pipe)	(doll)	1
11.	fish	The fish...	(fish)	(pie)	1
12.	balloon	The balloon...	(coat)	(balloon)	2
13.	leaf	Leaf...	(airplane)	(leaf)	2
14.	spoon	Spoon...	(spoon)	(deer)	1
15.	shoe	Shoe...	(flag)	(shoe)	2
16.	star	Star...	(star)	(pear)	1

MH Lesson 1.

Frame No.	Correct Concept	Commentary	Slide Description			Correct Exemplar
			Ex. 1		Ex. 2	
17.	flower	Flower	(flower)		(slide)	1
18.	candle	Candle...	(candle)		(house)	1
19.	gun	Gun...	(carrot)		(gun)	2
20.		Very good. Now you know how to press the button when you know which is the correct picture. The next thing we have to learn is how to find the correct picture. You have probably guessed how to find it. The green light tells you the correct picture is in the box with the same number as the light. All you have to do is get a green light and then look at the screen to see what picture is in the box. Let's see how this works.		(Blank)		
21.	bird	On this slide there is a house in box 1 and a bird in box 2. As soon as the yellow light goes on, press a button. If you get a green light, the correct picture is in the box with the same number as the button you pressed. If you got a red light, put out the red light and press the other button. The correct picture is in box 2, so it must be the bird. Now you are ready to use the booklet. Take the black marker and place it crosswise under the section for slide 1. Here you see the word house in box 1 and bird in box 2. The correct picture for slide 1 is the bird, so draw a circle around the word bird in box 2...	(house)		(bird)	2
22.		Like this. Look at the screen...Make sure your booklet looks like the picture on the screen...Let's have some practice in finding the correct picture.	house	Slide 1	[✓ bird]	
23.		As soon as the yellow light goes on, press a button. The light will tell you where to find the correct picture...This time you should get the green light in button 1. That means the rabbit is the correct picture. Move your marker to slide 2 in your booklet. Draw a circle around the word rabbit...	(rabbit)		(cup)	1

MH Lesson 1.

Frame No.	Correct Concept	Commentary	Slide Description			Correct Exemplar
			Ex. 1	Slide 2	Ex. 2	
24.		Like this...Look at the screen and make sure you have done it correctly in your booklet...Move your marker to slide 3.	rabbit		cup	
25.	key	Find the correct picture for this slide in the same way. As soon as you see the yellow light, press a button. If the red light comes on, put it out quickly and press the other button. Look at the number of the green-light picture. Look at the picture in the box with the same number. Circle the word for that picture in your booklet... You should have circled the word key. Turn the page in your booklet and put your marker under the section for slide 4.	(key)		(fan)	1
26.	bear	Press the button and get a green light...Now look at the screen. See what picture is in the box that got the green light...Circle the word for that picture in your booklet...You should have circled the word bear. Move your marker for slide 5.	(bear)		(lion)	1
27.	bell	Press a button and get a green light. Look at the screen... Circle the word in your booklet that goes with the green light... You should have circled bell. Move your marker for slide 6.	(girl)		(bell)	2
28.	pipe	Press a button and get a green light...Look at the screen. Circle the word for the green light picture...You should have circled pipe.	(pipe)		(doll)	1
29.		That was very good. Now we are going to do something just a little different.		(Blank)		
30.	fish	First let's find the correct picture. Press a button and get a green light. The green light tells you the correct picture. Turn the page in your booklet and place your marker for problem 1. Here you see the words pie and fish. Circle the word that goes with the green-light picture...You should have circled the word fish. This tells you the correct picture for the next slide.	(pie)		(fish)	2

MH Lesson 1.

Frame No.	Correct Concept	Commentary	Slide Description Ex. 1	Ex. 2	Correct Exemplar
31.		Look at this slide. Look at the word you circled, fish. Find the picture that goes with this word. You have to look at the screen to find where it is...Press the button which tells which box the fish is in this time...The green light tells you the picture you are looking for is in box 1...Move your marker to problem 2. Find the correct picture for this problem in the same way.	(fish)	(pie)	1
32.	balloon	Press a button and get a green light...Circle the word that goes with the green-light picture.	(balloon)	(coat)	1
33.		Look at the screen. Press the button that tells you where that picture is this time...Move your marker for problem 3.	(coat)	(balloon)	2
34.	leaf	Do the same thing here. Press a button and get a green light. Then, in your booklet, circle the word for the green-light picture...	(leaf)	(airplane)	1
35.		Press the button that tells where the picture you circled is this time...Turn the page and place your marker for problem 4...	(airplane)	(leaf)	2
36.		Now the game gets a little harder.	(Blank)		
37.	deer	Look at this slide. There are two pictures in box 1 and two pictures in box 2. It's not going to be quite so easy to find the correct picture. But you're going to learn a trick, a secret way of guessing this picture quickly. First, press a button and get a green light...Now you know the picture is in box 2, but you don't know which of the two pictures in box 2 is the correct one. It could be the spoon, or it could be the deer. In your booklet you see the words for the four pictures on the screen. Draw a box around the two words that go with the two green-light pictures...	(table barn)	(spoon deer)	2

MH Lesson 1.

Frame No.	Correct Concept	Commentary	Slide Description Ex. 1		Ex. 2	Correct Exemplar
38.		Like this. Look at the screen and see how your booklet should look.	table barn	Problem 4	spoon deer	
39.		On this slide one of the pictures you circled is in box 1, the other is in box 2. Now press a button and get a green light. The green light will tell you which of the two pictures in the box is the correct one...It is the spoon. Draw a circle around the word spoon...	(spoon)		(deer)	1
40.		Like this. Look at the screen and see how your booklet should look now.	table barn	Problem 4	spoon deer	
41.		This is the test slide. You know the correct picture. Look at the screen and find which box it is in...Press the button with the same number.	(deer barn)		(spoon table)	2
42.		Now you know the system for finding which one of four pictures is the correct one. The first two slides are your clue slides. It doesn't matter whether you get a red or a green light. But the third slide is the test slide. Here you should get a green light if you followed your clues. Move your marker for problem 5. Let's see how well you can work this system.		(Blank)		
43.	shoe	Press a button and get a green light...Draw a box around the two words for the pictures that got the green light...	(flag shoe)		(bird train)	1
44.		Your booklet should look like this...	flag shoe	Problem 5	bird train	
45.		Press a button and get a green light...Look at the screen...The green light tells you where to find the correct picture...Circle the word for this picture in your booklet...	(flag)		(shoe)	2
46.		Like this...Look at the screen. Remember, this is where you will learn the correct picture. Be sure to circle the correct word in your booklet.	flag shoe	Problem 5	bird train	

MH Lesson 1.

Frame No.	Correct Concept	Commentary	Slide Description Ex. 1	Slide Description Ex. 2	Correct Exemplar
47.		Now look at the screen and find the picture you circled. You should get a green light the first time.	(shoe bird)	(flag train)	1
48.		Here's our last practice problem for today. See how well you can follow your clues. Move your marker for problem 6.	(Blank)		
49.	star	Press a button and get a green light. Draw a box around the two words that go with the green-light pictures.	(star pear)	(lamp mouse)	1
50.		Press a button and get a green light. Draw a circle around one of the two words in the box that tells the correct picture.	(star)	(pear)	1
51.		Now look at the screen and find the picture you circled. Press the button for the box where you find this picture.	(pear lamp)	(mouse star)	2
52.		That was very good work. Tomorrow we'll come back and play this game again.	(Blank)		
MH Lesson 2.					
1.		You all know a method of finding out which one of four pictures I am thinking of. If you follow the clues in the first two clue slides, you should be able to guess my secret on the third slide. Now we are going to get more practice in following this system. Place your marker at problem 1 in your booklet.	(Blank)		
2.	flag	As soon as the yellow light goes on, press a button. It doesn't matter which button you press because either the red or the green light will give you the information you need. The green light says the picture is in the box with the same number as the button you pressed; the red light tells you that the picture is in the other box. The first thing you do is press your button and get a green light... Now look at the screen. Here we see a flag and a shoe in box 1, and a bird and a train in box 2. The green light tells you that the correct picture is in box 1. So you know it is either the flag or	(flag shoe)	(bird train)	1

MH Lesson 2.

Frame No.	Correct Concept	Commentary	Slide Description Ex. 1	Ex 2	Correct Exemplar
		the shoe. You still don't know exactly which one it is. But you know it is one of these two pictures. So, in your booklet, draw a box around the two words, flag and shoe.			
3.		Press a button and get a green light...Then look at the screen. Here there is a flag in box 1 and a shoe in box 2. The green light tells you that the correct picture is in box 1, so it must be the flag. Draw a circle around this word in your booklet. Now, no matter how many pictures there will be on the slide, you will be able to guess the correct picture. All you have to do is find which box the flag is in.	(flag)	(shoe)	1
4.		On this slide you look at the screen before you press a button because you don't need to guess any more. You know the correct picture is the flag. Find it. If it is in box 1, press button 1. If it is in box 2, press button 2. You should get a green light the first time.	(train flag)	(shoe bird)	1
5.		Move your marker for problem 2 and follow the same system.	(Blank)		
6.	candle	Press a button and get a green light...Draw a box around the two words that go with the green-light pictures. The words are house and candle.	(house candle)	(radio pail)	1
7.		Press a button and get a green light...Now look at the screen. There is a house in box 1 and a candle in box 2. The green light tells you which is the correct picture. Circle it...You should have circled candle.	(house)	(candle)	2
8.		Here is your test slide. Look at the screen. If you forget the correct picture, look at the word you circled. Find this picture on the screen. Be sure to press the button with the same number as the box in which you find the picture...You should get a green light in button 2.	(radio house)	(pail candle)	2

MH Lesson 2.

Frame No.	Correct Concept	Commentary	Slide Description Ex. 1	Slide Description Ex 2	Correct Exemplar
9.		Move your marker for problem 3.	(Blank)		
10.	gun	Press a button and get a green light...Look at the screen...Draw a box around the words for the two green-light pictures...The words are gun and carrot.	(saw fish)	(gun carrot)	2
11.		Press a button and get a green light...Look at the screen...There is a carrot in box 1 and a gun in box 2. The green light tells which is the correct picture. Circle it...You should have circled the gun.	(carrot)	(gun)	2
12.		Now let's see if you can get the green light on the first try. Look at the screen and find the picture for the circled word, gun. Press the button with the same number as the box in which you find it... You should have gotten a green light in box 2.	(carrot saw)	(fish gun)	2
13.		That was very good. Turn your page and place your marker for problem 4.	(Blank)		
14.	shoe	Press a button and get a green light...Look at the screen and see what pictures are in the box that goes with the green light...Draw a box around the words flower and shoe.	(flower shoe)	(knife kite)	1
15.		Press a button and get a green light...Look at the screen...You know that the correct picture can be only the flower or the shoe. The green-light box this time has the picture of the shoe and the kite. Since you already know the kite is wrong, it is drawn in a dotted line to help you remember it can't be the correct picture, even if it is in the correct box. The correct picture must be the shoe. Circle shoe in your booklet...Now on the next slide you will be able to choose the correct picture.	(flower KNIFE*)	(shoe KITE*)	2

* Capital letters indicate that pictures were drawn in dotted lines to reduce the stimulus effect of the irrelevant picture.

MH Lesson 2.

Frame No.	Correct Concept	Commentary	Slide Description Ex. 1	Slide Description Ex.2	Correct Exemplar
16.		Look at the screen...Find the picture that goes with the word you have circled. If you forget which picture you are looking for, look at your booklet for the circled word. Find which box the picture is in. Press the button with the same number... Yes, the correct picture, shoe, is in box 1.	(shoe knife)	(flower kite)	1
17.		Move your marker for problem 5.	(Blank)		
18.	pig	Press a button and get a green light...Now look at the screen for the green-light pictures...Draw a box around the two words that go with these pictures.	(banana cat)	(pig tree)	2
19.		Press a button and get a green light...Now look at the screen. Look at the picture in the green-light box in the last slide. Draw a circle around the word for this picture...You should have circled pig. Now you know the correct picture. Find it on the next slide.	(tree CAT*)	(*BANANA pig)	2
20.		Look at the screen and find the box with the correct picture... Press the button...You should get a green light the first time.	(pig cat)	(tree banana)	1
21.		Move your marker to problem 6.	(Blank)		
22.	truck	Press a button and get a green light...Look at the screen... Draw a box around the two words for the green-light pictures.	(hat truck)	(egg house)	1
23.		Press a button and get a green light...Now look at the screen. Look at the pictures in the green-light box. Find the one which was in the green-light box last time...Circle the word for this picture...You should have circled truck .	(egg hat)	(truck house)	2
24.		Look at the screen and find the box the picture is in this time. If you forget which picture you are looking for, look at the circled word in your booklet. If you circled the correct word you should get a green light. Press the button for this picture .	(truck egg)	(hat house)	1

MH Lesson 2.

Frame No.	Correct Concept	Commentary	Slide Description Ex. 1	Slide Description Ex. 2	Correct Exemplar
25.		Turn the page and place your marker for problem 7.	(Blank)		
26.	tent	Press a button and get a green light...Draw a box around the words for the green-light pictures.	(dress tent)	(horse car)	1
27.		Press a button and look at the green-light box. Find the picture which was in the green-light box last time...Circle the word for this picture.	(horse dress)	(tent car)	2
28.		Look at the screen before you press a button on the third slide. Find the box which has the correct picture...Press the button.	(car dress)	(tent house)	2
29.		Move your marker for problem 8. See if you can follow this system without any help.	(Blank)		
30.	boat	No instruction.	(fork bird)	(tree boat)	2
31.		No instruction.	(boat fork)	(bird tree)	1
32.		No instruction.	(fork tree)	(boat bird)	2
33.		Move your marker for problem 9. This is your last problem. Remember, the first two slides are your clue slides. It doesn't matter whether you get a red or a green light on these slides. But try to get a green light on the third slide.	(Blank)		
34.	flower	No instruction.	(corn pants)	(apple flower)	2
35.		No instruction.	(apple corn)	(flower pants)	2
36.		No instruction.	(pants apple)	(corn flower)	2
37.		That was very good work. That's all for today	(Blank)		

MH Lesson 3

Frame No.	Correct Concept	Commentary	Slide Description Type	 Ex. 1	 Model	 Ex. 2	Correct Exemplar
1.		Hello boys and girls. Today we are going to learn to play a matching game with some different slides. Look at the screen.			(Blank)		
2.	C	This slide has three pictures. The top picture is the model. It is the picture you are going to match. The top picture is green. Picture 1 is also green. Press button 1 for picture 1 which is the same color as the model...The green light tells you that you have pressed the correct button.	3312	1122	1124	1134	1
3.	S	This time the top picture is a diamond.. Press button 2 for the botton picture which is the same shape as the top picture...If you got a red light, you pressed the wrong button. Put your finger on the red-light button and put out the red light. Look at the slide more carefully. Match the shape of the top picture...	3312	1144	1143	1133	2
4.	S	Match the shape of this top picture...	3312	1112	1111	1121	2
5.	C	Match the color of the model...	3321	1132	1142	1143	2
6.	C	Press the button for the picture which is the same color as the model...	3312	1141	1143	1113	1
7.	S	Press for shape...	3321	1132	1122	1123	1
8.	C	Press for color...	3321	1141	1131	1134	2
9.	S	Now shape...	3321	1142	1112	1113	1
10.		That was very good. Now take your booklet and place your marker for slide 1...			(Blank)		
11.	C	As soon as the yellow light goes on, press a button. Look at the green-light picture. If it matches by color, write C for color in the proper box. If it matches by shape, write S for shape...Picture 1 is the same color as the model, so you should have written C in box 1...	3312	1132	1131	1121	1

Frame No.	Correct Concept	Commentary	Type	Ex. 1	Model	Ex. 2	Correct Exemplar
12.		Like this. Look at the screen and make sure you have written it correctly in your booklet...Move your marker for slide 2.		C 1	Slide 1	2	
13.	C	Press a button and get a green light. Look at the screen. Write the way the green-light picture matches in the proper box...You should have written C in box 2, this time. Move your marker for slide 3.	3321	1112	1122	1121	2
14.	S	Press a button and get a green light. Look at the screen. This Time picture 1 is the same shape as the model so write S in box 1.	3321	1133	1143	1144	1
15.		Like this...Look at the screen and be sure you have done it correctly...Turn the page and place your marker for slide 4.		S 1	Slide 3	2	
16.	S	Press a button and get a green light...Write the way the green-light picture matches in the proper box...You should have written S in box 2, this time. Move your marker for slide 5.	3312	1124	1123	1143	2
17.	C	Press a button and get a green light. Write the way the green-light picture matches...You should have written C in box 2...Move your marker for slide 6.	3321	1122	1112	1114	2
18.	S	Press a button and get a green light. Write the way the green-light picture matches...You should have written S in box 2.	3312	1141	1142	1112	2
19.		That was very good. Now we are going to learn a new rule for matching.			(Blank)		
20.	Z	Press a button and get a green light. The green light tells you that picture 2 is the correct picture. But it is neither the same color nor the same shape as the model. Then how does it match? Yes, it is a large design, just like the model. It is the same size as the model. Size is the new rule for matching.	3211	1243	1143	1131	2

MH Lesson 3

Frame No.	Correct Concept	Commentary	Slide Description Type	Ex. 1	Model	Ex. 2	Correct Exemplar
21.	Z	Look at this slide. Press the button for the picture which is the same size as the model...	3122	1234	1212	1112	1
22.		Turn to page 3 in your booklet and place your marker for slide 1.			(Blank)		
23.	Z	Find the picture which is the same size as the model. Since we have been using the letter S for shape, let's use Z for size. Write a Z in box 1 to show that picture 1 matches by the size rule. Press the button with the same number to tell me that you wrote the Z in the proper box...	3122	1133	1121	1221	1
24.		This is how your booklet should look now... Move your marker for slide 2.		Z 1	Slide 1	2	
25.	Z	Find the picture that matches by size. Write Z in the proper box ...Press the button with the same number as the box you wrote the Z in...Move your marker to slide 3.	3121	1244	1214	1112	1
26.	Z	Find the picture that matches by size. Write Z in the proper box...Press the button with the same number as the box.	3221	1122	1232	1231	2
27.		That was very good. Put your pencils down. Now we know three rules for matching. Let's see how quickly you can match by the rule I name.			(Blank)		
28.	S	As soon as the yellow light goes on, press the button for the picture which matches by shape.	3112	1144	1143	1233	2
29.	Z	Press the button for size.	3121	1212	1232	1131	1
30.	C	Color.	3211	1213	1113	1144	1
31.	C	Color.	3212	1133	1231	1211	1

Frame No.	Correct Concept	Commentary	Slide Description Type	Ex. 1	Model	Ex. 2	Correct Exemplar
32.	S	Shape.	3112	1124	1122	1232	2
33.	Z	Size.	3112	1223	1221	1131	1
34.	Z	Size.	3221	1141	1211	1212	2
35.	C	Color.	3212	1124	1223	1243	1
36.		Very good. Now turn to page 4 in your booklet...Place your marker for slide 1.			(Blank)		
37.	CS	Look at this slide. Here picture 2 is the same color and the same shape as the model. So write both letters, C and S, in box 2, to show that picture 2 matches the model in these two ways.	3122	1124	1143	1243	2
38.		Look at the screen. Your booklet should look like this... Move your marker for slide 2.		1	Slide 1	CS 2	
39.	ZC	Press a button and get a green light...Look at the screen...Write the two ways the green-light picture matches. Write two rules in the same box...Move your marker for slide 3.	3221	1114	1224	1222	2
40.	ZS	Press a button and get a green light...Write the two rules for matching in the same box...Turn the page and place your marker for slide 4.	3121	1132	1122	1221	1
41.	CS	Press a button and get a green light...Write the two rules for matching...Move your marker to slide 5.	3122	1233	1212	1112	2
42.	ZS	Press a button and get a green light...Write the two rules for	3212	1243	1144	1134	2
43.	ZC	Press a button and get a green light...Write the rules for matching ...Put your pencils down.	3112	1214	1211	1131	1
44.		Now we'll do something a little different.			(Blank)		

MH Lesson 3

Frame No.	Correct Concept	Commentary	Slide Description				Correct Exemplar
			Type	Ex. 1	Model	Ex. 2	
45.	ZS	Look at the screen. Find the picture which matches the model in both size and shape. Press the button with the same number as the matching picture . .	3312	1111	1113	1143	2
46.	SC	Press for shape and color...	3213	1121	1221	1241	1
47.	ZC	Press for size and color...	3312	1121	1123	1113	1
48.	SZ	Shape and size...	3123	1114	1134	1234	1
49.	ZS	Size and shape...	3321	1123	1143	1142	1
50.	ZC	Color and size...	3132	1222	1221	1121	1
51.	CS	Color and shape...	3132	1213	1214	1114	2
52.	ZC	Size and color...	3321	1112	1142	1141	2
53.	ZS	Size and shape...	3312	1143	1141	1131	2
54.	ZC	Size and color...	3312	1113	1111	1131	1
55.	CS	Color and shape...	3231	1221	1121	1122	1
56.	ZC	Size and color...	3321	1134	1144	1143	2
57.		That was very good. That's all for today.					

MH Lesson 4

Frame No.	Correct Concept	Commentary	Slide Description Type	Ex. 1	Model	Ex. 2	Correct Exemplar
1.		Now we know three rules for matching. Let's see how quickly you can match by the rule I name.			(Blank)		
2.	Z	Press the button for the picture which matches the size of the model...	3121	1223	1233	1134	1
3.	S	Press for shape...	3122	1142	1121	1221	2
4.	C	Press for color...	3121	1131	1141	1244	2
5.	Z	Press for size...	3212	1144	1243	1213	2
6.	C	Color...	3122	1133	1121	1221	2
7.	S	Shape...	3221	1242	1112	1111	1
8.	S	Shape...	3211	1213	1113	1144	1
9.	Z	Size...	3112	1221	1222	1142	1
10.		Now we are going to learn a new rule for matching.					
11.	N	Look at this slide. The model has two designs. Picture 2 also has two designs. Picture 2 matches the model by the number rule. Press button 2 to show that picture 2 matches by this rule: number...	2211	1123	2223	2241	2
12.	N	Find the picture which matches by the number rule...Press the button...	1212	2144	2241	4211	1
13.	N	Match by the number rule here...	1221	3214	3124	4123	1
14.	N	Press for number...	2121	4141	1111	1214	2
15.	N	Match number...	2112	1132	3133	3243	2

Frame No.	Correct Concept	Commentary	Type	Slide Description Ex. 1	Slide Description Model	Slide Description Ex. 2	Correct Exemplar
16.	N	Again, number...	2211	1241	2141	2123	2
17.		That was very good. Now take your booklet and place your marker for slide 1.			(Blank)		
18.	N	Look at the slide. Find the picture which has the same number of designs as the model. Write the letter N for the number in the proper box. Now press the button to tell me in which box you have written the N...	1244	1111	1223	3211	1
19.		This is what your booklet should look like now...Move your marker for slide 2 .		N 1	Slide 1	2	
20.	N	Look at the screen and find the picture which has the same number of designs as the model...Write N in the proper box. Press the button for that box...Move your marker to slide 3.	2154	1213	2232	2123	2
21.	N	Write N for the number in the proper box. Press the button to show which picture matches by the number rule...Turn the page and place your marker for slide 4.	2414	1112	3213	3122	2
22.	N	Write N...Press the button...Move your marker for slide 5.	1325	1213	1242	4241	1
23.	N	Write N ...Press the button...Move your marker for slide 6.	1452	1124	1241	2111	1
24.	N	Write N ...Press the button...	1442	4132	4211	3131	1
25.		That was very good. Now we'll do something different. Turn the page and place your marker for slide 1.					
26.	ZC	As soon as the yellow light goes on, press a button and get a green light...Look at the slide. The green light picture matches the model in two ways. Write the letters to tell these two rules for matching. Write both letters in the same box.	1221	4113	4233	3232	2

MH Lesson 4

Frame No.	Correct Concept	Commentary	Type	Slide Description Ex. 1	Slide Description Model	Slide Description Ex. 2	Correct Exemplar
					Slide 1		
27.		This is what your booklet should look like...Move your marker for slide 2.		1		ZC 2	
28.	NZ	As soon as the yellow light goes on, press a button and get a green light...Write the two rules for matching in the proper box...Move your marker for slide 3.	1122	1234	1223	2123	1
29.	CN	Press a button and get a green light...Write the two rules for matching in the same box...Turn the page and place the marker for slide 4.	2121	4113	3133	3234	2
30.	ZS	Press a button and get a green light...Write the matching rules ...Move your marker for slide 5.	2121	2231	4211	4142	1
31.	NS	Press a button and get a green light...Write the two rules for matching...Move your marker for slide 6.	2112	4242	2241	2111	2
32.	SC	Press a button and get a green light...Write the rules for matching...Turn the page and place your marker for slide 7.	1122	4241	4224	1124	2
33.	ZN	Press a button and get a green light...Write the rules...Move your marker for slide 8.	2211	3121	1221	1243	2
34.	CZ	Press a button and get a green light...Write the rules...Move your marker for slide 9.	2112	2142	1143	1223	1
35.	SZ	Press a button and get a green light...Write the rules.	1212	1221	1123	2143	2
36.		That was very good. Put your pencils down. Now we are going to have a test to see how well you have learned to play the matching game. I will name a rule for matching. You look at the slide and					

MH Lesson 4

Frame No.	Correct Concept	Commentary	Slide Description Type	Ex. 1	Model	Ex. 2	Correct Exemplar
		find the picture which matches by the rule I name. Then, as soon as the yellow light goes on, press the button with the same number as the matching picture. See how many green lights you can get. Ready?					
37.	N	Here's the first slide. Match by number...	1221	3242	3132	1131	1
38.	Z	Size...	2112	4244	1241	1111	1
39.	Z	Size...	2121	3132	4122	4223	1
40.	C	Color...	2121	3132	4122	4223	2
41.	S	Shape...	1221	3242	3112	2111	1
42.	S	Shape...	2211	1141	2241	2223	1
43.	Z	Size ...	1212	1234	1132	4122	2
44.	S	Shape...	1122	4111	4143	2243	2
45.	N	Number...	2211	4211	1111	1123	2
46.	C	Color...	2112	2223	4224	4134	1
47.	S	Shape...	2121	2241	1221	1123	1
48.	C	Color...	1221	2142	2232	4234	2
49.	Z	Size...	1221	4113	4233	3232	2
50.	N	Number...	1122	3124	3111	2211	1
51.	S	Shape...	1212	2221	2123	1143	2

MH Lesson 4

Frame No.	Correct Concept	Commentary	Type	Ex. 1	Model	Ex. 2	Correct Exemplar
52.	N	Number...	1122	1224	1233	2133	1
53.	N	Number...	1212	1223	1121	2141	1
54.	Z	Size...	2211	3231	1131	1114	2
55.	N	Number...	1122	1143	1121	2221	1
56.	C	Color...	1122	1223	1241	2141	2
57.	Z	Size...	2211	2213	3113	3121	2
58.	C	Color...	2211	1143	2243	2221	1
59.	S	Shape...	2112	1143	2141	2221	2
60.	C	Color ...	2121	1123	2143	2241	2
61.		That was very good. That's all for today.			(Blank)		

MH Lesson 5

Frame No.	Correct Concept	Commentary	Type	Ex. 1	Model	Ex. 2	Correct Exemplar
1.		Let's see if you can remember how to find which one of four pictures I'm thinking of. You know the first two slides are your clue slides. It doesn't matter whether you get a red or a green light on these two slides; either one will give you the same information. The object is to get a green light the first time on the third slide. In your booklet, place your marker for problem 1.			(Blank)		
2.	flag	Press a button and get a green light...Now look at the slide. Find the two green-light pictures. Draw a box around the two words for these pictures in your booklet, for problem 1...You should have chosen flag and shoe.		(flag shoe)		(bird train)	1

MH Lesson 5

Frame No.	Correct Concept	Commentary	Slide Description		
			Ex. 1	Ex. 2	Correct Exemplar
3.		Press a button and get a green light...Now look at the slide. If the flag is in the green-light box, circle the word flag; if it is the shoe, circle the word shoe...You should have circled flag.	(train flag)	(shoe bird)	1
4.		Now you know the correct picture. Look at the screen...Find it...Press the button with the same number as the box in which you find this picture...	(shoe bird)	(flag train)	2
5.		Move your marker for problem 2.	(Blank)		
6.	apple	As soon as the yellow light goes on, press a button and get a green light...Draw a box around the two words that go with the green-light pictures...	(pants corn)	(flower apple)	2
7.		Press a button and get a green light...Circle the word which goes with the green-light...Now you know the correct picture.	(corn apple)	(pants flower)	1
8.		Look at the screen...Find the picture which goes with the circled word...Press the button with the same number as the box in which you find the picture...	(apple pants)	(flower corn)	1
9.		Move your marker for problem 3.	(Blank)		
10.	boat	Press a button and get a green light...Draw a box around the two words that go with the green-light pictures...	(fork bird)	(tree boat)	2
11.		Press a button and get a green light...Circle the word which goes with the green-light picture...Now you know the picture I'm thinking of...Find it in the next slide.	(boat fork)	(tree bird)	1
12.		Look at the screen. Find the picture that goes with your circled word. Press the button with the same number as the box in which you find it.	(bird boat)	(tree fork)	1

Frame No.	Correct Concept	Commentary	Slide Description Ex. 1	Ex. 2	Correct Exemplar
13.		Now we are going to see something a little different, but we'll follow the same system of finding out what I am thinking of. Turn to page 2 and place your marker for problem 4. Here you see the four letters that go with our colored pictures. You know the N stands for number, Z for size, C for color, and S for shape. You know a method for guessing which rule I'm thinking of. Try it.	(Blank)		
14.	N	Press a button and get a green light . Look at the screen. Draw a box around the two letters that go with the green light...Now you know the rule is either number or size...	N Z	C S	1
15.		This is what your booklet should look like...	Problem 4 N Z	C S	
16.		Press a button and get a green light. Look at the screen. Which of the two possible rules goes with the green light? Draw a circle around this rule.	C Z	S N	2
17.		This is what your booklet should look like now...	Problem 4 N Z	C S	
18.		Now you know the correct rule. You should get a green light on the next slide. Look at this slide. Find the circled rule. Press the button with the same number as the box in which you find this rule.	Z S	N C	2
19.		Move your marker to problem 5.			
20.	S	Press a button and get a green light...Look at the screen. Draw a box around the green-light rules...	Z C	N S	2
21.		Press a button and get a green light...Look at the screen. Circle the rule which got the green light again...Now you know the rule. Try to get a green light the first time on the test slide.	S	N	1

MH Lesson 5

Frame No.	Correct Concept	Commentary	Type	Slide Description Ex. 1	Slide Description Model	Slide Description Ex. 2	Correct Exemplar
22.		Look at your circled rule. Look at the screen. Find the rule. Press the button with the same number as the box in which you find the circled rule...		C S		N Z	1
23.		Move your marker for problem 6.			(Blank)		
24.	C	Press a button and get a green light...Draw a box around the two green light rules...		C N		Z S	1
25.		Press a button and get a green light...Circle the rule which got the green light this time...		N S		C Z	2
26.		Look at the screen. Find the circled rule. Press the button for the box in which you find this rule...		S C		N Z	1
27.		Now we'll follow this system with the colored pictures. Move your marker for problem 7.			(Blank)		
28.	Z	As soon as the yellow light goes on, press a button. Look at the green-light picture. In your booklet draw a box around the two rules that tell how the green-light picture matches the model... You should have drawn the box around C and Z. Now you know the rule must be either color or size.	1221	1241	1121	2123	2
29.		Press a button and get a green light...Look at the green-light picture. If it matches the model by color, circle C; if by size, circle Z...The green-light picture matches by size so circle Z. Now you know the rule for matching this problem. Match by size rule on the next slide.	1212	2144	2241	4211	2
30.		Look at the screen. Find the picture which matches by size. Press the button with the same number as this picture.	2112	4224	2223	2113	1

MH Lesson 5

Frame No.	Correct Concept	Commentary	Type	Slide Description Ex. 1	Model	Ex. 2	Correct Exemplar
31.		Move your marker to problem 8. Find the rule for matching in the same way.			(Blank)		
32.	S	Press a button and get a green light. Draw a box around the two rules that tell how the green-light picture matches the model...	2211	1121	4221	4233	1
33.		Press a button and get a green light...Circle one of these two	1221	3241	3131	1134	1
34.		Look at the slide. Find the picture which matches by the circled rule. Press the button for this picture...	1122	4132	4121	2221	2
35.		Move your marker to problem 9.			(Blank)		
36.	N	Press a button and get a green light...Draw a box around the two rules for the green-light picture...	1221	2132	2222	1224	1
37.		Press a button and get a green light...Circle the rule that goes with the green light picture...	1122	4113	4141	2241	1
38.		Look at this slide. Find the picture which matches by the circled rule. Press the button for this picture...	1212	1232	1134	2124	1
39.		Turn the page for problem 10.			(Blank)		
40.	C	Press a button and get a green light...Draw a box around the two rules for the green-light picture...	1221	3231	3121	2122	2
41.		Press a button and get a green light...Circle one of the two possible rules that goes with this green light picture...	2121	1144	3134	3233	2
42.		Look at the slide. Find the picture that matches by the circled rule. Press the button...	2211	1222	4122	4113	1
43.		Move your marker for problem 11.			(Blank)		

Frame No.	Correct Concept	Commentary	Type	Slide Description Ex. 1	Model	Ex. 2	Correct Exemplar
44.	S	Press a button and get a green light...Draw a box around the two possible rules for this problem.	1212	2132	2233	4213	2
45.		Press a button and get a green light...Circle the possible rule that goes with the green-light picture...	2112	2122	3124	3244	2
46.		Look at the slide. Press the button for the picture which matches by your circled rule...	2121	4244	1214	1112	1
47.		Move your marker for problem 12.			(Blank)		
48.	S	Press a button and get a green light...Draw a box around the two possible rules for problem 12.	1221	4241	4131	3133	1
49.		Press a button and get a green light...Circle which of these possible rules tells how this green-light picture matches...	2121	3213	1233	1132	1
50.		Look at the slide. Press the button for the picture which matches by the circled rule...	2211	1213	2113	2134	1
51.		Now we're going to follow the same system, but this time you will write the possible rules for the green-light pictures. Turn the page and place your marker for problem 1.			(Blank)		
52.	C	Press a button and get a green light...Write the letters that tell how the green-light picture matches the model...You should have written C and S, like this...	1122	3234	3242	1142	2
53.		Look at the screen. This is what your booklet should look like...			Problem 1 Rules: C S		
54.		Press a button and get a green light...Look at the slide. Circle one of the two possible rules that goes with the green-light picture...	2121	1132	4112	4214	2

MH Lesson 5 Frame No.	Correct Concept	Commentary	Type	Slide Description Ex. 1	Model	Ex. 2	Correct Exemplar
55.		Like this...Look at the screen to see what your booklet should look like now...			Problem 1 Rules: [✓ C] S		
56.		Press the button for the picture which matches by your circled rule...	2121	3221	1241	1143	2
57.		Move your marker for problem 2.			(Blank)		
58.	N	Get a green light...Write the two rules for the green-light picture...	2121	3143	2133	2234	2
59.		Get a green light...Circle one of the two possible rules which tells how this green-light picture matches...	2112	1234	3231	3141	2
60.		Look at the slide. Press the button for the picture which matches by the circled rule...	1212	4213	4114	3144	1
61.	Z	Move your marker to problem 3. This is your last problem.			(Blank)		
62.		Get a green light...Write the two possible rules for matching...	2112	1143	4142	4222	1
63.		Get a green light...Circle one of the possible rules which tells how this green-light picture matches...	2211	4131	1231	1242	2
64.		Now see if you can get a green light the first time. Look at the slide. Press the button for the picture which matches by your circled rule...	2121	4113	1123	1222	1
65.		That was very good. That's all for today.					

MH Lesson 6

Frame No.	Correct Concept	Commentary	Type	Slide Description Ex. 1	Model	Ex. 2	Correct Exemplar
1.		Now you know the four rules for matching. Let's see how quickly you can find the picture which matches by the rule I name.			(Blank)		
2.	Z	Size...	1122	3122	3114	2214	1
3.	N	Number...	2112	2223	1221	1141	2
4.	N	Number...	1212	2141	2243	1223	1
5.	C	Color...	1122	2144	2133	4233	2
6.	Z	Size...	1122	2143	2121	1221	1
7.	S	Shape...	1122	1221	1243	2143	2
8.		That was very good. Now take your booklets and place your marker for problem 1.			(Blank)		
9.	N	As soon as the yellow light goes on, press a button and get a green light. Look at the green-light picture. This picture matches the model in two ways. It is the same size and it has the same number of designs as the model. On the rule line for problem 1 write N and Z to show that these are the two possible rules for problem 1.	1122	4242	4224	3124	1
10.		This is what your booklet should look like...		Problem 1 Rules: N Z			
11.		Press a button and get a green light...Now look at the screen. If the green-light picture matches by number, circle N; if it matches by size, circle Z...You should have circled N...	1221	1231	1141	2142	
12.		Like this...Now you know the rule for matching is number. Use this rule for the rest of the slides in problem 1...		Problem 1 Rules: Ⓝ Z			

MH Lesson 6

Frame	Correct				Slide Description		
No.	Concept	Commentary	Type	Ex. 1	Model	Ex. 2	Correct Exemplar
13.		Look at the screen. Find the picture which matches by the rule you circled. Press the button for this picture...	2121	2232	4212	4111	2
14.		Look at the screen. Press the button for the picture which matches by your circled rule...	2211	2211	4111	4143	2
15.		Look at the screen. Match by the same rule here. If you forget the rule, look at the circled rule for problem 1...	1221	2213	2133	1132	1
16.		Match by the same rule...	1122	2141	2114	3214	1
17.		Now we have a new problem. Move your marker to problem 2. Find the rule for this problem in the same way.			(Blank)		
18.	Z	As soon as the yellow light goes on, press a button and get a green light. Look at the screen. Write the two rules for the green-light picture on the rule lines for problem 2...	2112	1234	4231	4111	1
19.		Get a green light...Look at the screen. If the green-light picture matches by number, circle N; if it matches by size, circle Z...You should have circled Z this time. Size is the correct rule for problem 2 by this rule.	1122	1124	1141	3241	1
20.		Look at the screen. Press the button for the picture that matches by size...	2121	1142	2122	2221	1
21.		Match by the same rule...	2211	4221	1121	1143	2
22.		If you forget your rule, look at the circled letter in your booklet...	1221	2214	2134	1131	2
23.		Use the same rule again...	1122	4131	4143	3243	1
24.		Move your marker for problem 3. Find the rule in the same way.			(Blank)		

MH Lesson 6

Frame No.	Correct Concept	Commentary	Type	Slide Description Ex. 1	Slide Description Model	Slide Description Ex 2.	Correct Exemplar
25.	S	Press a button and get a green light...Look at the screen. Write the two rules for problem 3 on the rule lines...	2121	3213	2233	2132	1
26.		Get a green light...Circle the rule for the green-light picture... Now you should know the rule for matching. Use this rule on the next slide.	1221	3131	3221	2222	1
27.		Match by the same rule...If you should get a red light, check to see if you matched correctly. If you did, then you must have made a mistake when you wrote down the rules. Cross out the rules you have written and write the rules for this green-light picture.	1122	2123	2132	4232	2
28.		Press a button and get a green light...Make sure you have circled the correct rule for the green-light picture.	2112	1241	3242	3122	2
29.		Use the same rule here for matching...	2121	3144	4114	4212	1
30.		Once more, the same rule...	1122	1214	1232	4132	2
31.		Turn the page and place your marker for problem 4.			(Blank)		
32.	C	Press a button and get a green light...Write the two green light rules...	1212	1241	1144	4124	1
33.		Get a green light...Circle one of your rules for the green-light picture...	2112	3143	4144	4234	1
34.		Look at the slide. Press the button for the picture which matches by your circled rule...	2211	2213	1113	1131	1
35.		Match by the circled rule...If you get a red light, start over again. Cross out the rules you have written and write the rules for the green-light picture...	1212	3223	3124	1144	1

MH Lesson 6

Frame No.	Correct Concept	Commentary	Type	Slide Description			Correct Exemplar
				Ex. 1	Model	Ex. 2	
36.		Match this picture in the same way...	1221	2224	2114	1112	2
37.		Once again, the same rule...	1221	3231	3121	1123	2
38.		Move your marker for problem 5.			(Blank)		
39.	C	Press a button and get a green light...Write the two green-light rules...	1122	3241	3223	1123	2
40.		Get a green light...Circle one of your rules for the green-light picture...	1221	4114	4234	3233	2
41.		Look at the slide. Match by your circled rule...If you get a red light, start over again...	2211	4214	3114	3143	1
42.		Do the same thing here...	1212	4241	4144	3134	1
43.		Match by your circled rule...	1212	1211	1112	3142	1
44.		Again, the same rule...	2121	1232	3222	3121	2
45.		Move your marker for problem 6.			(Blank)		
46.	Z	Get a green light...Write the two green-light rules...	1212	3214	3113	1123	2
47.		Get a green light...Circle one of these two rules...	1122	1132	1114	2214	1
48.		Match by the circled rule...If you get a red light, start again...	1212	4241	4143	1123	2
49.		Do the same thing here...	2112	2122	1124	1234	1
50.		Match by the circled rule...	1122	4212	4244	3144	1

MH Lesson 6

Frame No.	Correct Concept	Commentary	Slide Description				Correct Exemplar
			Type	Ex. 1	Model	Ex. 2	
51.		The same rule again...	1221	2221	2111	1113	2
52.		Turn the page and place your marker for problem 7.			(Blank)		
53.	N	Get a green light...Write the two rules...	2112	3212	2213	2133	2
54.		Get a green light...Circle the rule for matching...	1221	3121	3211	4212	1
55.		Match by your circled rule...If you get a red light, start again.	1212	3223	3122	1132	1
56.		Do the same thing here...	1221	3243	3132	1131	1
57.		Match by the circled rule...	2112	3234	4232	4122	2
58.		Again, the same rule...	1212	4143	4244	2214	1
59.		Move your marker for problem 8. Let's see how well you can follow this method of finding the rule without any help.			(Blank)		
60.	S	No instruction.	2112	3234	4232	4122	2
61.		No instruction.	1122	1241	1223	2123	2
62.		No instruction.	2121	3132	1112	1213	1
63.		No instruction.	1212	3121	3222	2212	2
64.		No instruction.	2211	3233	2133	2142	1
65.		No instruction.	2112	1144	4143	4213	2
66.		Move your marker for problem 9. This is your last problem. Let's see if you can find the rule for matching from the two clue slides. Then, get four green lights in a row.					

MH Lesson 6

Frame No.	Correct Concept	Commentary	Type	Slide Description Ex. 1	Model	Ex. 2	Correct Exemplar
67.	Z	No instruction.	2211	2213	3113	3121	2
68.		No instruction.	1212	2113	2211	1221	2
69.		No instruction.	2112	1234	3231	3141	1
70.		No instruction.	1221	1231	1111	3112	2
71.		No instruction.	2121	4142	3122	3221	1
72.		No instruction.	1122	4234	4242	1142	1
73.		That was very good. That's all for today.			(Blank)		
MH Lesson 7							
1.		Today we are going to have some more practice in finding the rule for matching. But first let's see how quickly you can match by the rule I name.			(Blank)		
2.	N	Number...	1212	2141	2243	1223	1
3.	S	Shape...	1122	2144	2133	4233	2
4.	S	Shape...	2112	2223	1221	1141	2
5.	N	Number...	1122	3122	3114	2214	1
6.	C	Color...	1122	1221	1243	2143	2
7.	Z	Size...	1122	2143	2121	1221	1

MH Lesson 7

Frame No.	Correct Concept	Commentary	Type	Slide Description Ex. 1	Slide Description Model	Slide Description Ex. 2	Correct Exemplar
8.		That was very good. Now let's play the matching game. You know the first two slides in each problem are your clue slides. They give you the information you need to find the rule. It doesn't matter whether you get a red or a green light on the first two slides. The object of the game is to get four green lights in a row after your clue slides tell you the rule for matching. Today there are two cards in your booth. You know the rule card tells you all four rules for matching. The second card reminds you of the system you are to follow in finding the rule. Let's read these directions: Press the button. Circle one rule. Match with your circled rule...Now we are ready to start. Place your marker for problem 1.			(Blank)		
9.	Z	As soon as the yellow light goes on, press a button. It doesn't matter whether you get a red or a green light. Now look at the screen... Write the two rules for the green-light picture.	1221	1231	1111	3112	2
10.		Again, press a button and get a green light. Look at the slide and circle one of the two rules you wrote down, the one which tells how the green-light picture matches. Now you should know the rule for matching for problem 1.	2211	2213	3113	3121	2
11.		Match by your circled rule. If you get a red light, cross out your rules and start again. Write the two rules for the green-light picture.	1212	2113	2211	1221	2
12.		Do the same thing here.	1122	4234	4242	1142	1
13.		Match by the circled rule.	2112	1234	3231	3141	1
14.		Use the same rule again.	2121	4142	3122	3221	1
15.		Move your marker to problem 2 and follow the same system.			(Blank)		

MH Lesson 7

Frame No.	Correct Concept	Commentary	Type	Slide Description Ex. 1	Model	Ex. 2	Correct Exemplar
16.	S	Get a green light. Write the two rules for matching.	1212	3121	3222	2222	2
17.		Get a green light. Circle the rule for the green-light picture.	2112	1144	4143	4213	2
18.		Match by this rule. If you get a red light, cross out your rules and start again. Write the rules for the green-light picture.	2211	3233	2133	2142	1
19.		Do the same thing here.	2112	3234	4232	4122	2
20.		Match by your circled rule.	2121	3132	1112	1213	1
21.		Once more, the same rule.	1122	1241	1223	2123	2
22.		Move your marker for problem 3. Find the rule using this same system.			(Blank)		
23.	C	Get a green light. Write the two rules for the green-light picture.	2211	4214	3114	3143	1
24.		Get a green light. Circle one of your two rules for this green-light picture.	1221	4114	4234	3233	2
25.		Match by the circled rule. If you get a red light, start again.	1212	4241	4144	3134	1
26.		Do the same thing.	1122	3241	3223	1123	2
27.		Match by the circled rule.	2121	1232	3222	3121	2
28.		Once more, the same rule.	1212	1211	1112	3142	1
29.		Turn the page and place your marker for problem 4. Now let's see how well you can follow this system without any help. If you forget the rules, look at the rule card; if you forget the steps in your rule-finding system, look at the system card.			(Blank)		

Frame No.	Correct Concept	Commentary		Slide Description			Correct Exemplar
			Type	Ex. 1	Model	Ex. 2	
30.	N	No instruction.	1221	1231	1141	2142	1
31.		No instruction.	1121	4242	4224	3124	1
32.		No instruction.	2121	2232	4212	4111	2
33.		No instruction.	2211	2211	4111	4143	2
34.		No instruction.	1122	2141	2114	3214	1
35.		No instruction.	1221	2213	2133	1132	1
36.		Move your marker for problem 6. Follow the same system.			(Blank)		
37.	N	No instruction.	1221	3242	3132	1131	1
38.		No instruction.	1212	3223	3122	1132	1
39.		No instruction.	2112	3234	4232	4122	2
40.		No instruction.	2112	3212	2213	2133	2
41.		No instruction.	1221	3121	3211	4212	1
42.		No instruction.	1212	4143	4244	2214	1
43.		Move your marker for problem 7. Follow the same system.			(Blank)		
44.	Z	No instruction.	1122	4212	4244	3144	1
45.		No instruction.	2112	2122	1124	1234	1
46.		No instruction.	1122	1132	1114	2214	1

MH Lesson 7

Frame	Correct	Commentary		Slide Description			Correct
No.	Concept		Type	Ex. 1	Model	Ex. 2	Exemplar
47.		No instruction.	1212	3214	3113	1123	2
48.		No instruction.	1221	2221	2111	1113	2
49.		No instruction.	1212	4241	4143	1123	2
50.		Turn the page. Now you see only blank paper. You are really on your own. But if you keep following the system, you should be able to find the rule for matching.			(Blank)		
51.	C	No instruction.	1221	2224	2114	1112	2
52.		No instruction.	1212	3223	3124	1144	1
53.		No instruction.	2112	3143	4144	4234	1
54.		No instruction.	1221	3231	3121	1123	2
55.		No instruction.	1212	1241	1144	4124	1
56.		No instruction.	2211	2213	1113	1131	1
57.		This is a new problem. Draw a line under the rules you wrote for the last problem and do the same thing here.			(Blank)		
58.	S	No instruction.	1122	1214	1232	4132	2
59.		No instruction.	2112	1241	3242	3122	2
60.		No instruction.	2121	3213	2233	2132	1
61.		No instruction.	1221	3131	3221	2222	1
62.		No instruction.	2121	3144	4114	4212	1

MH Lesson 7

Frame No.	Correct Concept	Commentary	Slide Description				Correct Exemplar
			Type	Ex. 1	Model	Ex. 2	
63.		No instruction.	1122	2123	2132	4232	2
64.		Here's your last problem. See if you can get four green lights in a row, after your two clue slides.			(Blank)		
65.	S	No instruction.	2211	2213	3113	3121	1
66.		No instruction.	1212	2113	2211	1221	2
67.		No instruction.	2112	1234	3231	3141	2
68.		No instruction.	1221	1231	1111	3112	1
69.		No instruction.	2121	4142	3122	3221	1
70.		No instruction.	1122	4234	4242	1142	2
71.		That was very good. That's all for today.					
MH Lesson 8							
1.		Today is the last day we will have to practice our system of finding the rule for matching in the matching game. Because we want you to get used to working without any help, your booklets have only blank sheets of paper. But you still have your system cards to remind you of the way to go about finding the correct rule for each problem. Let's try the first one now.			(Blank)		
2.	C	Press a button. Get a green light. Write the two rules for matching the green-light picture.	1212	1241	1144	4124	1
3.		Press a button. Get a green light. Circle one of the rules you have written down...the one which tells how this green-light picture matches.	2112	3143	4144	4234	1

MH Lesson 8

Frame No.	Correct Concept	Commentary	Type	Slide Description Ex. 1	 Model	 Ex. 2	Correct Exemplar
4.		Look at the screen. Find the picture which matches by your circled rule. Press the button for the matching picture...If you get a red light, cross out your rules and start again. Write the two rules for the green-light picture.	2211	2213	1113	1131	1
5.		Look at the screen. Press the button for the picture which matches by your rule.	1212	3223	3124	1144	1
6.		Match by the same rule here.	1221	2224	2114	1112	2
7.		Again, the same rule.	1221	3231	3121	1123	2
8.		Draw a line across the page. Now find the rule for problem 2 in the same way.			(Blank)		
9.	Z	Press a button. Get a green light. Write the two rules for matching the green-light picture.	2112	1234	4232	4112	1
10.		Get a green light. Circle one rule that goes with the green-light picture.	1122	1124	1141	3241	1
11.		Look at the slide. Press the button for the picture which matches by your circled rule. If you get a red light, cross out your rule and start again. Write the two rules for the green-light picture.	2121	1142	2122	2221	1
12.		Do the same thing here.	2211	4221	1121	1143	2
13.		Match by the same rule.	1221	2214	2134	1131	2
14.		Again, the same rule.	1122	4131	4143	3243	1
15.		Draw a line and get ready for problem 3.			(Blank)		

MH Lesson 8

Frame No.	Correct Concept	Commentary	Slide Description Type	Ex. 1	Model	Ex. 2	Correct Exemplar
16.	Z	Get a green light. Write the two rules for the green-light picture.	1212	3214	3113	1123	2
17.		Get a green light. Circle the rule which tells the way the green-light picture matches.	1122	1132	1114	2214	1
18.		Look at the screen. Press the button for the picture which matches by the circled rule...If you get a red light, cross out your rule and start again. Write the two rules for the green-light picture.	1212	4241	4143	1123	2
19.		Match in the same way here.	2112	2122	1124	1234	1
20.		Use the circled rule for matching.	1122	4212	4244	3144	1
21.		Again, the same rule.	1221	2221	2111	1113	2
22.		Turn the page. Now I'm not going to give you any more help. Just keep on following the same system for finding the rule for each problem. If you forget the rules, look at the rule card. If you forget the steps for finding the correct rule, look at the system card. See how well you can follow the system for finding the rule for matching. You should be able to guess the correct rule with the second slide.			(Blank)		
23.	S	No instruction.	2121	3213	2233	2132	1
24.		No instruction.	1221	3131	3221	2222	1
25.		No instruction.	1122	2123	2132	4232	2
26.		No instruction.	2112	1241	3242	3122	2
27.		No instruction.	2121	3144	4114	4212	1
28.		No instruction.	1122	1214	1232	4132	2

Frame No.	Correct Concept	Commentary	Type	Slide Description			Correct Exemplar
				Ex. 1	Model	Ex. 2	
29.		This is a different problem. Find the rule in the same way.			(Blank)		
30.	S	No instruction.	2112	3234	4232	4122	2
31.		No instruction.	1122	1241	1223	2123	2
32.		No instruction.	2121	3132	1112	1213	1
33.		No instruction.	1212	3121	3222	2222	2
34.		No instruction.	2211	3233	2133	2142	1
35.		No instruction.	2112	1144	4143	4213	2
36.		This is a different problem. Find the rule in the same way.			(Blank)		
37.	N	No instruction.	1122	4242	4224	3124	1
38.		No instruction.	1221	1231	1141	2142	1
39.		No instruction.	2121	2232	4212	4111	2
40.		No instruction.	2211	2211	4111	4143	2
41.		No instruction.	1221	2213	2133	1132	1
42.		No instruction.	1122	2141	2114	3214	1
43.		Turn to the next page. Find the rule for this problem.			(Blank)		
44.	N	No instruction.	2112	3212	2213	2133	2
45.		No instruction.	1212	3223	3122	1132	1

MH Lesson 8

Frame No.	Correct Concept	Commentary	Slide Description				Correct Exemplar
			Type	Ex. 1	Model	Ex. 2	
46.		No instruction.	1221	3121	3211	4212	1
47.		No instruction.	1221	3242	3132	1131	1
48.		No instruction.	2112	3234	4232	4122	2
49.		No instruction.	1212	4143	4244	2214	1
50.		Here's another problem.			(Blank)		
51.	N	No instruction.	2112	3234	4232	4122	2
52.		No instruction.	1122	1241	1223	2123	1
53.		No instruction.	2121	3132	1112	1213	2
54.		No instruction.	1212	3121	3222	2212	1
55.		No instruction.	2211	3233	2133	2142	2
56.		No instruction.	2112	1144	4143	4213	2
57.		This is the last problem. Try to get four green lights on the last four slides.			(Blank)		
58.	C	No instruction.	1212	4241	4144	3134	1
59.		No instruction.	1122	3241	3223	1123	2
60.		No instruction.	2121	1232	3222	3121	2
61.		No instruction.	1221	4114	4234	3233	2

MH Lesson 8

Frame No.	Correct Concept	Commentary	Type	Slide Description Ex. 1	Slide Description Model	Slide Description Ex. 2	Correct Exemplar
62.		No instruction.	2211	4214	2114	2143	1
63.		No instruction.	1212	1211	1112	3142	1
64.		That was very good. That's all for today.			(Blank)		

3. The program for teaching the Single Hypothesis strategy

SINGLE HYPOTHESIS TRAINING

SH Lesson 1 Frame No.	Correct Concept	Commentary	Type	Slide Description Ex. 1	Model	Ex. 2	Correct Exemplar
1.		Today we are going to learn how to play a matching game. Like most games, you have to learn certain rules before you can play. There are some materials in your booth which we will be using later. But first, look at the little gray box in front of you. It is your control panel. There are five buttons, but the three buttons in the middle have caps over them. You are going to use only the button with the _1_ under it and the button with the _2_ under it... Now look at the screen.			(Blank)		
2.	CS	There is a slide with two pictures on the bottom. Picture 1 is a red bean; picture 2 is a green circle. When the yellow light in front of your panel goes on...now...press button 1 for the red bean...You got a green light because button 1 goes with picture 1.		1114		1121	1
3.	CS	On this slide, picture 1 shows a black circle and picture 2 a yellow star. Press button 2 for picture 2, the yellow star...		1131		1142	2
4.	CS	Press the button for the green circle...		1121		1144	1
5.	CS	The black star...		1132		1143	1
6.	CS	Red diamond...		1131		1113	2
7.	CS	Green bean...		1124		1112	1
8.		That was very good. Now the next slide is a little different.			(Blank)		

SH Lesson 1

Frame No.	Correct Concept	Commentary	Type	Slide Description Ex. 1	Model	Ex. 2	Correct Exemplar
9.	C	This slide has three pictures. The top picture is the model. It is the picture you are going to match. The top picture is green. Picture 1 is also green. Press button 1 for picture 1 which is the same color as the model...The green light tells that you have pressed the right button.	3312	1122	1124	1134	1
10.	S	This time the top picture is a diamond. Picture 2 is also a diamond. Press button 2 for the bottom picture which is the same shape as the top picture.	3312	1144	1143	1133	2
11.	S	Match the shape of this top picture. If you get a red light it means you pressed the wrong button.	3312	1112	1111	1121	2
12.	C	Match color...	3321	1132	1142	1143	2
13.	C	Again, color...	3312	1141	1143	1113	1
14.	S	Now, shape...	3321	1132	1122	1123	1
15.	C	Color...	3321	1141	1131	1134	2
16.	S	Shape...	3321	1142	1112	1113	1
17.	C	Color...	3321	1113	1143	1141	2
18.	S	Shape...	3312	1111	1114	1144	2
19.		That was very good. Now you know how to press a button to tell which picture matches the model. Take your booklet. Each section has two boxes. These boxes are numbered 1 and 2 just as the buttons are. Place your marker under the boxes for slide 1.			(Blank)		

SH Lesson 1

Frame No.	Correct Concept	Commentary	Type	Slide Description			Correct Exemplar
				Ex. 1	Model	Ex. 2	
20.	C	Now look at the screen. Picture 1 is the same color as the model so write the letter C for color in box 1...	0010	1113	1112		1
21.		This is what your booklet should look like...Move your marker for slide 2.		C 1	Slide 1	2	
22.	C	Look at slide 2. Here there is no picture 1 so box 1 on your paper should be left empty, just like on the slide. Picture 2 is the same color as the model. So write C in box two to show how picture 2 matches the model...Move your marker for slide 3.	0020		1133	1134	2
23.	S	Here picture 1 matches the model by shape. Write the letter S, for shape, in box 1 to show that picture 1 is the same shape as the model...	0001	1143	1133		1
24.		This is what your booklet should look like now...Turn the page and place your marker for slide 4.		S 1	Slide 3	2	
25.	C	Write the letter that tells the rule for slide 4...Move your marker for slide 5.	0020		1141	1142	2
26.	S	Write the rule for slide 5...Move your marker for slide 6.	0002		1112	1122	2
27.	S	Write the rule for slide 6...Turn the page and place your marker for slide 7.	0001	1121	1141		1
28.	C	Write the rule for slide 7...Move your marker to 8.	0010	1121	1124		1
29.	S	Write the rule for slide 8...Move your marker to 9.	0002		1134	1114	2
30.	S	Write the rule for slide 9...Turn to page 4 in your booklet.	0001	1112	1142		1
31.		That was very good. Now we'll try something a little different. Place your marker for slide 1			(Blank)		

SH Lesson 1

Frame No.	Correct Concept	Commentary	Slide Description Type	Ex. 1	Model	Ex. 2	Correct Exemplar
32.	CS	Look at this slide. Picture 1 is the same shape as the model, so put the letter S in box 1...Picture 2 is the same color as the model, so put C in box 2...	3321	1111	1131	1133	1S - 2C
33.		There are pictures in both bottom boxes, so you should have a letter in both boxes on your paper, like this...Move your marker for slide 2.		S 1	Slide 1	C 2	
34.	CS	Write the letter that tells how picture 1 matches the model... Now write the letter that tells how picture 2 matches...Move your marker for slide 3.	3312	1144	1142	1122	1C - 2S
35.	CS	Write the letter that tells how picture 1 matches...Then how picture 2 matches ...Turn the page and place your marker for slide 4.	3321	1123	1113	1112	1S - 2C
36.	CS	Write the letter for picture 1...Then write the letter for picture 2...Move your marker for slide 5.	3312	1133	1134	1144	1C - 2S
37.	CS	Write the letters that tell how these pictures match...Move your marker for slide 6.	3312	1143	1142	1132	1C - 2S
38.	CS	Write the letters here...Turn the page and place your marker for slide 7.	3321	1143	1113	1111	1S - 2C
39.	CS	Write the letters...Move your marker for slide 8.	3321	1131	1121	1131	1S - 2C
40.	CS	Write the letters...Move to slide 9.	3312	1123	1124	1144	1C - 2S
41.	CS	Write the letters...Turn to page 7.	3312	1121	1123	1113	1C - 2S
42.		That was very good...Now we are going to play a guessing game. I'm going to choose a rule, color or shape. You have to guess which					

SH Lesson 1

Frame No.	Correct Concept	Commentary	Type	Slide Description Ex. 1	Model	Ex. 2	Correct Exemplar
		rule I've chosen. Here's how it works. Choose a rule for matching. Let's take color.					
43.	C	Now look at the slide. Picture 2 matches by color, so write C in box 2...Press button 2 to see if you have guessed the rule...The green light in button 2 tells you that color is the correct rule for matching this slide. You have guessed the secret rule. Move your marker for the next slide. Choose a rule for matching. Let's try color again.	3321	1143	1123	1124	2
44.	S	Look at the slide. Picture 2 is the same color as the model, so write a C in box 2. Press button 2...The red light tells you that you didn't guess the rule this time. Move your marker to slide 3. Choose a rule for matching: either color or shape.	3321	1131	1141	1143	1
45.	S	Look at the slide. Find a picture which matches by the rule you chose. Write the letter in the proper box. Press the button that goes with this picture...The green light tells when you have guessed the rule. Turn the page and place the marker for slide 4. Choose a rule: either color or shape.	3312	1122	1123	1133	2
46.	C	Look at the slide and find the picture which matches by the rule you chose. Write the letter in the proper box. Press the button that goes with this picture...If you got a red light, you didn't guess the correct rule. Place your marker for slide 5. Do the same thing again. Choose a rule and write it in the proper box.	3312	1142	1144	1124	1
47.	S	Press the button that goes with the matching picture...Move your marker for slide 6. Again. Choose a rule and write it in the proper box.	3312	1134	1131	1141	2
48.	S	Press the button for the picture that goes with this rule... Turn to page 9.	3321	1121	1111	1112	1

SH Lesson 1

Frame No.	Correct Concept	Commentary	Type	Slide Description Ex. 1	Slide Description Model	Slide Description Ex. 2	Correct Exemplar
49.		That was a good beginning. Let's get some more practice in writing the matching rules.			(Blank)		
50.	C	Press button 2. In box 2 On your paper, write how picture 2 matches the model...Move your marker to slide 2.	3321	1144	1114	1111	2
51.	C	Press button 1. In box 1, write how picture 1 matches the model ...Move your marker to slide 3.	3312	1112	1113	1123	1
52.	S	Press button 1. In box 1, write the rule for picture 1...Turn the page and place the marker for slide 4.	3321	1124	1134	1132	1
53.	C	Press button 1. In box 1, write the rule for picture 1...Place your marker for slide 5.	3312	1142	1143	1123	
54.	C	Press button 2. In box 2, write the rule for picture 2...Move your marker for slide 6.	3321	1121	1131	1132	2
55.	S	Press button 2. In box 2, write the rule for picture 2...	3312	1133	1132	1122	2
56.		That was very good work. That's all for today.					
SH Lesson 2							
1.		Now we are going to play the matching game. Let's see how quickly you can find the bottom picture which matches the model.			(Blank)		
2.	C	As soon as the yellow light goes on, press the button for color...	3321	1111	1141	1144	2
3.	C	Again, color...	3321	1131	1121	1123	2
4.	S	Shape...	3321	1113	1133	1131	1

SH Lesson 2

Frame No.	Correct Concept	Commentary	Type	Slide Description Ex. 1	Model	Ex. 2	Correct Exemplar
5.	C	Color...	3312	1124	1122	1142	1
6.	S	Shape...	3312	1123	1122	1132	2
7.	S	Shape...	3321	1122	1132	1133	1
8.	S	Shape...	3321	1114	1134	1131	1
9.	C	Color...	3321	1124	1114	1113	2
10.		That was very good. In all the slides you have just seen, one picture matched the model in color and the other matched the model in shape. I told you which was the right way to match, which way would get you the green light, color or shape. In the next part of the matching game, you have to guess the secret rule for matching. Look at the pink page in your booklet. On this page there are two rules for matching, C and S. Circle one of these rules. This time circle S for shape. Shape will be the correct rule for matching all the slides in the first problem.			(Blank)		
11.		Here is what your booklet should look like.			Problem 1 C Ⓢ		
12.	S	Look at your booklet. Look at the rule you have circled for matching. It's shape. Now look at the slide. Find the picture which is the same shape as the model...Press the button...The green light tells you have the correct rule for matching.	3321	1141	1111	1114	1
13.	S	Look at the rule in your booklet. It is shape. Look at the screen. Find the picture which is the same shape as the model...Press the button.	3312	1111	1114	1134	2
14.	S	Look at the rule you have circled. Look at the slide. Find the picture which matches the model according to this rule...Press the button.	3321	1124	1144	1142	1

SH Lesson 2

Frame No.	Correct Concept	Commentary	Type	Slide Description Ex. 1	Model	Ex. 2	Correct Exemplar
15.	S	Again, the same rule...	3312	1134	1132	1142	2
16.		That's the end of the first problem. Now turn to page 2 in your booklet. This is a blue page . Choose a rule for matching. Either color or shape. Circle one of the letters on page 2.			(Blank)		
17.	C	Now look at the screen. Find the picture which matches according to this rule...Press the button for the matching picture...If you got a green light, you guessed the correct rule. Match all the slides in this problem by the rule you have circled. If you got a red light, you didn't guess the correct rule. Cross it out and circle the other rule.	3321	1114	1144	1141	2
18.	C	Look at the rule you have circled...Look at the screen...Press the button for the matching picture...If you got a green light you guessed the correct rule for matching. Try it on the next slide.	3312	1131	1133	1113	1
19.	C	Look at the rule you have circled...Now look at the screen... Find the picture which matches the model by this rule...Press the button.	3321	1141	1121	1124	2
20.	C	Look at the rule...Look at the slide and find the picture which matches by this rule...Press the button.	3312	1111	1112	1132	1
21.		Turn to the yellow page in your booklet. .			(Blank)		
22.	C	Circle the rule for matching on the yellow page. Now look at the slide and find the picture which matches by this rule. Press the button with the same number as the matching picture. If you get a red light, you guessed the wrong rule. Cross it out and circle the other rule.	3321	1143	1133	1134	2

SH Lesson 2

Frame No.	Correct Concept	Commentary	Type	Slide Description Ex. 1	Slide Description Model	Slide Description Ex. 2	Correct Exemplar
23.	C	Look at the rule you have circled...Look at the slide...Press the button for the matching picture...You should get a green light. Use this rule on the next slide.	3321	1144	1124	1123	2
24.	C	Look at the rule you have circled...Look at the screen...Press the button.	3312	1114	1112	1122	1
25.	C	Look at the rule...Look at the screen...Press the button.	3312	1144	1141	1111	1
26.		Now turn to page 4, the white page.			(Blank)		
27.	S	Circle a rule for matching...Look at the screen...Press the button for the matching picture...If you get a green light, use this same rule next time. If you get a red light you guessed the wrong rule. Cross it out and circle the other rule.	3321	1121	1141	1142	1
28.	S	Look at the rule you have circled...Now be sure to look at the slide...Press the button for the matching picture...You should get a green light. Use this rule on the next slide.	3321	1111	1121	1122	1
29.	S	Look at the rule,then look at the slide...Press the button for the matching picture.	3312	1114	1113	1133	2
30.	S	Look at the rule...Look at the screen...Press the button.	3312	1144	1141	1111	2
31.		That was very good. Turn to page 5.			(Blank)		
32.	Z	Look at the screen. Here neither picture 1 nor picture 2 is the same color or the same shape as the model. But picture 1 is large, like the model. Picture 2 is small. So picture 1 matches because it is the same size. Size is a new way of matching. Since we have been writing S for shape, let's write Z, for size, in box 1 to show that here the rule for matching is size...Move your marker to section 2.	3144	1141	1124	1241	1

SH Lesson 2

Frame No.	Correct Concept	Commentary	Type	Slide Description Ex. 1	Model	Ex. 2	Correct Exemplar
33.		Here is what your booklet should look like now.		$\boxed{\frac{Z}{1}}$	Slide 1	$\boxed{2}$	
34.	Z	Here picture 2 is large and the model is large, so picture 2 matches in size. Write Z for size in box 2...Move your marker to section 3.	3245	1232	1141	1133	2
35.	Z	Picture 2 is small like the model, so write Z in box 2.	3254	1133	1221	1243	2
36.		Turn to page 6.			(Blank)		
37.	S	In box 1 write whether picture 1 matches the model by size, shape, or color. You should have written S in box 1...Move your marker to slide 2.	3221	1212	1132	1131	1
38.	Z	Write whether picture 1 matches the model by size, color, or shape. You should have written Z for size...Move your marker to section 3.	3122	1122	1131	1231	1
39.	S	Write how picture 2 matches the model...S is correct. Turn the page and place your marker for slide 4.	3112	1134	1131	1241	2
40.	C	Write how picture 1 matches...C is correct. Move your marker to slide 5.	3212	1224	1121	1111	1
41.	C	Write how picture 2 matches...Move your marker to section 6.	3121	1111	1131	1232	2
42.	C	Write whether picture 2 matches in size, color or shape... Turn to page 8.	3121	1244	1214	1112	2
43.	S	Write how picture 1 matches. Move your marker.	3221	1224	1134	1133	1
44.	C	Write how picture 2 matches.	3121	1242	1212	1113	2

SH Lesson 2 Frame No.	Correct Concept	Commentary	Type	Ex. 1	Model	Ex. 2	Correct Exemplar
45.	S	Write how picture 2 matches.	3112	1213	1212	1122	2
46.		Now we'll play the matching game with three rules: color, shape, and size.			(Blank)		
47.	C	Look at the slide...Press the button for the picture which matches by color.	3212	1141	1244	1234	1
48.	S	Press the button for the picture which matches by shape.	3221	1224	1144	1143	1
49.	Z	Match by size...	3122	1214	1243	1143	1
50.	Z	Match by size...	3122	1233	1212	1112	1
51.	S	Match shape...	3122	1134	1131	1241	2
52.	C	Match color...	3121	1121	1141	1243	2
53.	Z	Match size...	3211	1122	1222	1213	2
54.	S	Match shape...	3221	1141	1211	1212	1
55.	Z	Match size...	3122	1231	1244	1144	1
56.		That was very good. That's all for today.					
SH Lesson 3							
1.		Hello boys and girls. Let's play the matching game. Now we all know three rules for matching: color, size, and shape. See how quickly you can find the picture which matches by the rule I name.			(Blank)		

Slide Description (columns Type, Ex. 1, Model, Ex. 2)

SH Lesson 3

Frame No.	Correct Concept	Commentary	Type	Ex. 1	Slide Description Model	Ex. 2	Correct Exemplar
2.	Z	First let's match by size. On this slide, the top picture has a large design: it is a large star. We want to find a bottom picture which also has a large design. Picture 2 is a large circle, so picture 2 matches the model in size. Press button 2.	3221	1212	1132	1131	2
3.	Z	Let's match by size again. Here the model is a small design. Find the bottom picture which also has a small design...Press the button for the picture which matches by the size rule.	3121	1223	1243	1144	1
4.	C	Now match the color of the model...	3221	1242	1112	1[illegible]	2
5.	S	Match shape...	3212	1214	1112	1122	2
6.	C	Color...	3212	1213	1112	1122	1
7.	S	Shape...	3211	1134	1234	1211	1
8.		Now we are going to learn a different rule for matching.			(Blank)		
9.	N	Look at the screen. The model has two large red stars. Picture 1 has three small black stars and picture 2 has two small black stars. Both picture 1 and picture 2 are small black stars, so there is no way to choose between them for size, color, or shape. The only difference is that picture 2 has the same number of stars. That is the new rule for matching: number. Press button 2 to show that picture 2 matches by the number rule.	2443	3232	2112	2232	2
10.	N	The model here has three beans. Press the button for the picture with the same number of designs...	1355	3211	3224	2232	1
11.	N	Press the button for the picture which matches by number...	1444	4141	4213	1141	1
12.	N	Match by the number rule...	2455	2243	1114	1222	2

SH Lesson 3

Frame No.	Correct Concept	Commentary		Slide Description			Correct Exemplar
			Type	Ex. 1	Model	Ex. 2	
13.	N	Match by number...	1454	4232	4141	3212	1
14.	N	Number...	2455	2211	3143	3232	2
15.		That was very good. You all know a new rule: number. Now take your booklet and place your marker for slide 1.			(Blank)		
16.	N	Look at the slide. Find the picture which has the same number of designs as the model. Write the first letter of the word number, the N in box 2 to show that the picture 2 matches by the number rule.	2455	2243	1114	1222	2
17.		This is what your booklet should look like...Move your marker for slide 2.		1	Slide 1	N 2	
18.	N	Find the picture with the same number of designs as the model. Write the letter for number, the N, in the proper box...Move your marker for slide 3.	1454	1124	1232	2114	1
19.	N	Write N for number in the proper box...Turn to the next page and place your marker for slide 4.	2455	2211	3143	3232	2
20.	N	Write N for number in the proper box...Move your marker for slide 5.	1454	4232	4141	3212	1
21.	N	Write N for the picture which matches by the number rule... Move your marker for slide 6.	2455	4132	3221	3113	2
22.	N	Write N for number in the proper box.	1444	2234	2142	3234	1
23.		That was very good. You know four rules for matching: color, shape, size, and number. We're going to play a matching game using these rules. Turn to the pink page in your booklet. On this					

SH Lesson 3

Frame No.	Correct Concept	Commentary	Type	Slide Description			Correct Exemplar
				Ex. 1	Model	Ex. 2	
24.	N	Look at the screen. Remember, your rule for matching is number. Press the button for the picture which matches by the number rule...You should get a green light.	1422	2131	2242	4142	1
25.	N	Look at the rule you circled: number. Look at the screen. Find the picture with the same number of designs as the model...Press the button...If you got a red light you didn't match correctly.	2151	3143	1113	1232	2
26.	N	Look at the rule you circled...Look at the screen...Press the button for the matching picture...	1225	4221	4114	2112	1
27.	N	Look at the rule...Look at the screen...Press the button...	2411	1134	4234	4143	2
28.		Now turn to the blue page in your booklet. The rule for problem 2 is size, so circle Z which stands for size.			(Blank)		
29.	Z	Look at your circled rule. It is size. Look at the screen... Press the button for the picture which matches by the size rule...	5211	1113	3213	2231	2
30.	Z	Be sure to look at the rule, then look at the screen...Press the button for the matching picture...	2124	1123	2132	2233	1
31.	Z	Match by the same rule. If you forget the rule, look at the blue page in your booklet...	5122	1242	3224	4124	1
32.	Z	The same rule here...	2124	4122	3113	3212	1
33.		Turn to the yellow page. Circle C for color. This is the rule matching all the slides in problem 3.			(Blank)		
34.	C	Look at the rule you have circled. Now be sure to look at the screen...Press the button for the picture which matches by this rule...	1421	4142	4222	1121	2

SH Lesson 3

Frame No.	Correct Concept	Commentary	Slide Description Type	Ex. 1	Model	Ex. 2	Correct Exemplar
35.	C	Match by the same rule. If you forget the rule for matching, look at the yellow page in your booklet...	2215	2141	4244	4231	1
36.	C	Use the same rule for matching. Press the button...	2421	3243	4113	4214	2
37.	C	Again, the same rule...	5112	2141	3142	4232	1
38.		Turn to the white page. Circle the letter S for shape. This is the rule for matching problem 4.			(Blank)		
39.	S	Look at the rule...look at the screen...Press the button for the matching picture...	1412	3212	3113	4233	2
40.	S	Match by the circled rule. Be sure to look at the screen and choose the picture that matches by the circled rule...	4221	4232	3142	4141	1
41.	S	Be sure to look at your rule, then at the screen...Press the button for the matching picture...	2151	4113	2144	2224	2
42.	S	Look at your rule...look at the screen. Press the button. . .	5121	4241	2221	3124	1
43.		That was very good. Put down your pencils. Now we are going to have a little test to see how well you have learned to play the matching game. I will tell you the rules for matching. You have to look at the slide and find the picture which matches by the rule I name. Then, as soon as the yellow light goes on, press the button with the same number as the matching picture. See how many green lights you can get. Ready?			(Blank)		
44.	N	Here's the first slide. Match by number...	1221	3242	3132	1131	1
45.	Z	Size...	2112	4244	1241	1111	1

SH Lesson 3

Frame No.	Correct Concept	Commentary	Slide Description Type	Ex. 1	Model	Ex. 2	Correct Exemplar
46.	Z	Size...	2121	3132	4122	4223	1
47.	C	Color...	2121	3132	4122	4223	2
48.	S	Shape...	1221	3242	3112	2111	1
49.	S	Shape...	2211	1141	2241	2223	1
50.	Z	Size...	1212	1234	1132	4122	2
51.	S	Shape...	1122	4111	4143	2243	2
52.	N	Number...	2211	4211	1111	1123	2
53.	C	Color...	2112	2223	4224	4134	1
54.	S	Shape...	2121	2241	1221	1123	1
55.	C	Color...	1221	2142	2232	4234	2
56.	Z	Size...	1221	4113	4233	3232	2
57.	N	Number...	1122	3124	3111	2211	1
58.	S	Shape...	1212	2221	2123	1143	2
59.	N	Number...	1122	1224	1233	2133	1
60.	N	Number...	1212	1223	1121	2141	1
61.	Z	Size ...	2211	3231	1131	1114	2
62.	N	Number...	1122	1143	1121	2221	1

SH Lesson 3

Frame No.	Correct Concept	Commentary	Slide Description Type	Ex. 1	Model	Ex. 2	Correct Exemplar
63.	C	Color...	1122	1223	1241	2141	2
64.	Z	Size...	2211	2213	3113	3121	2
65.	C	Color...	2211	1143	2243	2221	1
66.	S	Shape...	2112	1143	2141	2221	2
67.	C	Color	2121	1123	2143	2241	2
68.		That was very good. That's all for today.					
SH Lesson 4							
1.		You all know four rules for matching. Now we are going to see how well you can use these rules in our matching game. In this game there are six slides for each problem. All the slides in any one problem are matched by the same rule. The object of the game is to find the rule for matching as quickly as you can, and then to use this rule to get green lights on the rest of the slides of that problem. The blank slide tells when you have reached the end of a problem. Then you have to find the rule for the next problem. Sometimes it will be the same rule, and sometimes it will be a different rule. There is a card in your booth to remind you of the four rules for matching. Choose a rule for matching, then look at the screen...			(Blank)		
2.	S	Press the button that goes with your rule...	2112	2124	1122	1232	2
3.	S	Match the top picture...	2121	2224	3214	3111	1
4.	S	Match this picture...	1221	2113	2243	3244	1

SH Lesson 4

Frame No.	Correct Concept	Commentary	Slide Description				Correct Exemplar
			Type	Ex. 1	Model	Ex. 2	
5.	S	Match by the same rule...	2211	1132	4232	4243	1
6.	S	Again, the same rule...	2112	2224	1222	1142	2
7.	S	Here's the last slide for this problem. Try to get a green light...	2211	4241	2141	2132	1
8.		This is a different problem. Find the rule for matching...			(Blank)		
9.	N	No instruction...	2121	4241	2211	2114	2
10.	N	No instruction...	1221	4241	4131	2133	1
11.	N	No instruction...	2211	4121	2221	2212	2
12.	N	No instruction...	1212	4214	4111	2141	1
13.	N	No instruction...	2211	2131	4231	4243	2
14.	N	No instruction...	1212	3133	3231	2221	1
15.		This is another problem. Find the rule as quickly as you can...			(Blank)		
16.	S	No instruction...	1212	4144	4242	3222	2
17.	S	No instruction...	2112	1132	2134	2244	2
18.	S	No instruction...	2211	2244	4144	4113	1
19.	S	No instruction...	1221	2214	2134	4133	1
20.	S	No instruction...	2211	4222	1122	1113	1
21.	S	No instruction...	1212	3131	3233	4243	2

SH Lesson 4

Frame No.	Correct Concept	Commentary	Slide Description Type	Ex. 1	Model	Ex. 2	Correct Exemplar
22.		Here's another problem. Find the rule.			(Blank)		
23.	Z	No instruction.	2211	2242	3142	3113	2
24.	Z	No instruction.	1221	4132	4212	2211	2
25.	Z	No instruction.	2121	4141	2121	2222	1
26.	Z	No instruction.	1122	1224	1242	4142	1
27.	Z	No instruction.	1221	1112	1232	2231	2
28.	Z	No instruction.	1122	2143	2122	4222	1
29.		Now another problem.			(Blank)		
30.	C	No instruction.	1122	1232	1241	3141	2
31.	C	No instruction.	2112	2231	1232	1112	1
32.	C	No instruction.	1122	3141	3123	4223	2
33.	C	No instruction.	1221	1131	1211	4213	2
34.	C	No instruction.	1212	1134	1233	4213	1
35.	C	No instruction.	1221	2133	2213	1211	2
36.		Find the rule for this problem in the same way.			(Blank)		
37.	C	No instruction.	1122	3131	3114	1214	2

SH Lesson 4

Frame No.	Correct Concept	Commentary	Slide Description				Correct Exemplar
			Type	Ex. 1	Model	Ex. 2	
38.	C	No instruction.	2112	1224	3223	3133	1
39.	C	No instruction.	1212	2142	2244	1234	1
40.	C	No instruction.	1122	4242	4221	3121	2
41.	C	No instruction.	1221	2124	2214	3211	2
42.	C	No instruction.	2112	3232	2234	2124	1
43.		Now this problem.			(Blank)		
44.	N	No instruction.	1221	1141	1211	4212	1
45.	N	No instruction.	2211	4214	1114	1123	2
46.	N	No instruction.	1212	2242	2144	3134	1
47.	N	No instruction.	1221	4142	4222	1224	1
48.	N	No instruction.	2121	4141	3111	3212	2
49.	N	No instruction.	2211	4214	3114	3121	2
50.		Here's another problem.			(Blank)		
51.	N	No instruction.	2211	3214	2114	2131	2
52.	N	No instruction.	2112	1114	2112	2242	2
53.	N	No instruction.	2211	1221	3121	3114	2

SH Lesson 4

Frame No.	Correct Concept	Commentary	Type	Slide Description Ex. 1	Model	Ex. 2	Correct Exemplar
54.	N	No instruction.	1221	1212	1122	3121	1
55.	N	No instruction.	1212	1222	1123	4113	1
56.	N	No instruction.	1221	4231	4121	3123	1
57.		Now another problem.			(Blank)		
58.	S	No instruction.	1221	4113	4243	3242	1
59.	S	No instruction.	1212	3212	3114	1144	2
60.	S	No instruction.	2112	1131	2133	2213	2
61.	S	No instruction.	2121	3223	1243	1141	1
62.	S	No instruction.	2112	4143	1141	1231	2
63.	S	No instruction.	2121	4211	1231	1133	1
64.		This is the last problem. See how quickly you can find the rule.			(Blank)		
65.	Z	No instruction.	2121	2133	4113	4212	1
66.	Z	No instruction.	2112	2143	4141	4231	1
67.	Z	No instruction.	1221	3132	3242	2241	2
68.	Z	No instruction.	1122	4221	4214	1114	1
69.	Z	No instruction.	1212	2243	2144	1134	2
70.	Z	No instruction.	2211	2122	3224	3243	2

SH Lesson 4

Frame No.	Correct Concept	Commentary	Type	Slide Description Ex. 1	Model	Ex. 2	Correct Exemplar
71.		That was very good. I think you all did very well, with the little practice you have had so far. Tomorrow we'll get to play the matching game again.			(Blank)		
SH Lesson 5							
1.		Yesterday you all had a chance to play the matching game without any help. Now I'm going to show you a method or system which will help you find the rule for matching more quickly. Place your marker for slide 1 in your booklet. Then look at the screen.			(Blank)		
2.	Z	One of the bottom pictures has the same size designs as the model. Find that picture and write the letter Z for size in the box in your booklet with the same number...Then press the button with the same number as the box in which you wrote the rule...You should get a green light in button 2 because picture 2 has large-size designs, just like the model...Move your marker to slide 2.	1221	3214	3124	4124	2
3.	N	Find the bottom picture which has the same number of designs as the model. Write N for number in the proper box...Press the button to see if you wrote the N in the correct box for the matching picture...Move your marker for slide 3.	2121	4113	3133	3234	2
4.	N	Find the picture that matches by the number rule here...Write N for number in the proper box...Press the button...Turn the page and place your marker for slide 4.	1212	2112	2211	3231	1
5.	Z	Find the picture that matches by the size rule. Write Z in the proper box...Press the button...Move your marker for slide 5.	2211	2111	3211	3244	2

SH Lesson 5

Frame No.	Correct Concept	Commentary	Slide Description				Correct Exemplar
			Type	Ex. 1	Model	Ex. 2	
6.	S	Write S for shape in the proper box...Press the button... Move your marker for slide 6.	1212	2113	2211	1221	2
7.	C	Write C for color in the proper box...Press the button...	1212	3121	3222	2212	1
8.		That was very good. Now turn to the blue page in your booklet. Here there is an S for shape and a Z for size. All the slides in problem 1 will match by the same rule. Circle the S for shape. Shape is the rule for problem 1.			(Blank)		
9.	S	Press the button for the picture which matches by shape...	5142	1213	2231	3111	2
10.	S	Match by the same rule...If you forget the rule for matching, look at the circled rule in your booklet.	5142	3122	1113	2223	2
11.	S	Press for the matching picture...	5251	1221	2131	3112	1
12.		Turn to the yellow page for problem 2. Now you choose a rule for matching. Circle the rule you choose, either size or number... Use this rule for matching the next slide.			(Blank)		
13.	Z	Press the button for the picture which matches the model by your circled rule. If you get a green light, use this rule for matching all the slides in problem 2. If you get a red light, cross out the rule you circled and circle the other rule. It doesn't matter whether you got a red or a green light on the first slide. Either red or green will give you the same information...Now you should know the rule, so you should be able to get a green light on the rest of the slides in this problem. Do not turn the page. You are still on the blue page for problem 1.	1255	3221	3113	1132	2
14.	Z	Look at the slide...Press the button for the picture which matches by the rule you have circled on the blue page...	2145	3133	2111	2232	1

SH Lesson 5

Frame No.	Correct Concept	Commentary	Slide Description Type	 Ex. 1	 Model	 Ex. 2	 Correct Exemplar
15.	Z	Match by the same rule here.	1254	3112	3233	2222	2
16.		Turn to the white page for problem 3. Circle either Z for size or C for color. Do this quickly. It doesn't matter which you choose. One has as much chance of being correct as the other. You won't be able to tell which is right until you try.			(Blank)		
17.	C	Look at the screen...Press the button for the picture which matches by your circled rule...If you get a green light, use the same rule for matching. If you get a red light, cross out your rule and circle the other rule. Now you know the correct rule for problem 3. Match all the slides with this rule.	5215	1223	2121	3112	1
18.	C	Look at the screen...Match by the circled rule...	5125	2122	3111	1213	2
19.	C	Use the same rule for matching this slide...	5212	3132	1231	2213	1
20.		Turn to the pink page for problem 4. Circle either N for the number rule or the C for the color rule.			(Blank)		
21.	N	Press the button for the picture which matches by the rule you circled...The green light tells you to use the same rule next time. The red light tells you to cross out the first rule you tried and circle the other one.	2415	3212	4114	4223	2
22.	N	Look at the screen...Match by the circled rule...	1424	3144	3233	1134	1
23.	N	Again, match by the circled rule...	2414	1112	3213	3122	2
24.		Turn to the blue page for problem 5. Circle one of the rules on this page.			(Blank)		

SH Lesson 5

Frame No.	Correct Concept	Commentary	Slide Description Type	Ex. 1	Model	Ex. 2	Correct Exemplar
25.	N	Press the button for the picture which matches by the rule you circled...If you get a red light, cross out this rule and circle the other rule...Now you should know the rule for problem 5.	2451	2141	4221	4134	2
26.	N	Look at the screen...Match by the circled rule...	1452	1143	1234	2124	1
27.	N	Use the circled rule again...	2441	3131	4211	4132	2
28.		Now let's see how well you can play the matching game without any help. Turn to the blue page for problem 6. Here there are all four rules for matching. See how quickly you can find the correct rule for each problem.			(Blank)		
29.	N	No instruction.	1122	1223	1241	2141	1
30.	N	No instruction.	2112	4143	2142	2212	2
31.	N	No instruction.	2121	3231	2211	2114	2
32.	N	No instruction.	2211	1222	4122	4141	2
33.	N	No instruction.	1221	1233	1143	2144	1
34.	N	No instruction.	2121	3233	1243	1142	2
35.		Turn to the yellow page for problem 7. See how quickly you can find the rule for matching.			(Blank)		
36.	C	No instruction.	1221	3124	3234	2233	2
37.	C	No instruction.	2121	1241	2221	2123	2
38.	C	No instruction.	2211	4142	3242	3211	1

SH Lesson 5

Frame No.	Correct Concept	Commentary	Slide Description Type				Correct Exemplar
			Type	Ex. 1	Model	Ex. 2	
39.	C	No instruction.	1212	3233	3134	4114	1
40.	C	No instruction.	1122	4212	4223	1123	2
41.	C	No instruction.	1212	1222	1123	4133	1
42.		Turn to the white page for problem 8. Find the rule.			(Blank)		
43.	Z	No instruction.	2211	2222	4122	4131	2
44.	Z	No instruction.	2112	1142	3143	3233	1
45.	Z	No instruction.	2121	1214	4224	4123	1
46.	Z	No instruction.	2112	1122	2123	2243	1
47.	Z	No instruction.	1212	4233	4131	3121	2
48.	Z	No instruction.	2112	1223	2222	2141	1
49.		Turn to the pink page for problem 9.			(Blank)		
50.	N	No instruction.	2112	3111	1114	1234	2
51.	N	No instruction.	1212	2241	2143	1123	1
52.	N	No instruction.	2211	4234	3134	3123	2
53.	N	No instruction.	1221	4213	4123	2122	1
54.	N	No instruction.	2121	4244	2234	2132	2

SH Lesson 5

Frame No.	Correct	Commentary	Slide Description Type	 Ex. 1	 Model	 Ex. 2	Correct Exemplar
55.	N	No instruction.	2211	1114	3214	3211	2
56.		Turn to the blue page for problem 10. This is the last problem.			(Blank)		
57.	S	No instruction.	2211	3231	1131	1112	1
58.	S	No instruction.	2112	1144	4143	4213	2
59.	S	No instruction.	1212	3244	3141	1131	2
60.	S	No instruction.	2121	3233	1223	1122	1
61.	S	No instruction.	1221	4111	4231	1234	1
62.	S	No instruction.	2112	1241	2243	2123	2
63.		That was very good work. That's all for today.			(Blank)		
SH Lesson 6							
1.		Today we are going to have some more practice in finding the rule for matching. But first, let's see how quickly you can match by the rule I name.			(Blank)		
2.	N	Number ...	1212	2141	2243	1223	1
3.	S	Shape...	1122	2144	2133	4233	2
4.	S	Shape...	2112	2223	1221	1141	2
5.	N	Number...	1122	3122	3114	2214	1
6.	C	Color...	1122	1221	1243	2143	2

SH Lesson 6

Frame No.	Correct Concept	Commentary	Slide Description Type	Ex. 1	Model	Ex. 2	Correct E xemplar
7.	Z	Size...	1122	2143	2121	1221	1
8.		That was very good. Now let's play the matching game. The object of this game is to find the rule for matching each problem as quickly as possible. Today there are two cards in your booth. You know the rule card tells you all four rules for matching. The second card reminds you of the system you are to follow in finding the rule. Let's go over the steps you are to follow. First, choose a rule for matching. Circle or write it on your booklet. Then press the button with the same number as the picture which matches by the rule you circled. If you get a green light, use this rule on the next slide; if you get a red light, cross out the circled rule and circle a different rule. Now we are ready to start. Take your booklet and circle one of the rules for matching on the yellow page.			(Blank)		
9.	Z	Press a button for the picture which matches by the rule you circled...If you get a green light, use this rule next time. If you get a red light, cross out the circled rule and circle a different rule.	1221	1231	1111	3112	2
10.		Look at the circled rule...Look at the screen...Press the button for the picture which matches by the circled rule...If you get a red light, cross out your rule, even if you got a green light with this rule the first time. You must get two green lights in a row to be sure you have the correct rule for the problem. So try another rule.	2211	2213	3113	3121	2
11.		Look at the screen...Press the button for the picture which matches by your circled rule...If you get a red light, cross out this rule and circle another one...	1212	2113	2211	1221	2
12.		Match by the circled rule...	1122	4234	4242	1142	1

SH Lesson 6

Frame No.	Correct Concept	Commentary	Slide Description				Correct Exemplar
			Type	Ex. 1	Model	Ex. 2	
13.		Again, the same rule...	2112	1234	3231	3141	1
14.		Use the same rule again...	2121	4142	3122	3221	1
15.		Turn to the white page for problem 2...Circle a rule for matching.			(Blank)		
16.	S	Look at the screen...Press the button for the matching picture... If you get a red light, cross out the circled rule and circle a different rule...	1212	3121	3222	2222	2
17.		Look at the screen...Match by the circled rule...	2112	1144	4143	4213	2
18.		Match by the circled rule...If you get a red light, cross out the rule and try a different one...	2211	3233	2133	2142	1
19.		Do the same thing here...	2112	3234	4232	4122	2
20.		Match by your circled rule...	2121	3132	1112	1213	1
21.		Once more, the same rule... .	1122	1241	1223	2123	2
22.		Turn to the pink page for problem 3...Circle a rule for matching.			(Blank)		
23.	C	Press the button for the matching picture...If you get a red light, cross out the circled rule and circle another rule...	2211	4214	3114	3143	1
24.		Match by the circled rule...If you get a red light, cross out the circled rule and try a different rule...	1221	4114	4234	3233	2
25.		Match by the same rule...	1212	4241	4144	3134	1
26.		Do the same thing here...	1122	3241	3223	1123	2

SH Lesson 6

Frame No.	Correct Concept	Commentary	Type	Slide Description Ex. 1	Model	Ex. 2	Correct Exemplar
27.		Match by the circled rule...	2121	1232	3222	3121	2
28.		Once more, the same rule...	1212	1211	1112	3142	1
29.		Turn to the blue page for problem 4. Find the rule for this problem in the same way. If you forget how to do it, look at the card which tells you how to find the rule.			(Blank)		
30.	N	No instruction.	1221	1231	1141	2142	1
31.		No instruction.	1121	4242	4224	3124	1
32.		No instruction.	2121	2232	4212	4111	2
33.		No instruction.	2211	2211	4111	4143	2
34.		No instruction.	1122	2141	2114	3214	1
35.		No instruction.	1221	2213	2133	1132	1
36.		Turn to the yellow page for problem 5. Find the rule in the same way. Your system card will help you remember what to do.			(Blank)		
37.	N	No instruction.	1221	3242	3132	1131	1
38.		No instruction.	1212	3223	3122	1132	1
39.		No instruction.	2112	3234	4232	4122	2
40.		No instruction.	2112	3212	2213	2133	2
41.		No instruction.	1221	3121	3211	4212	1

SH Lesson 6

Frame No.	Correct Concept	Commentary	Type	Slide Description Ex. 1	Model	Ex. 2	Correct Exemplar
42.		No instruction.	1212	4134	4244	2214	1
43.		Turn to the white page for problem 6...Find the rule here.			(Blank)		
44.	Z	No instruction.	1122	4212	4244	3144	1
45.		No instruction.	2112	2122	1124	1234	1
46.		No instruction.	1122	1132	1114	2214	1
47.		No instruction.	1212	3214	3113	1123	2
48.		No instruction.	1221	2221	2111	1113	2
49.		No instruction.	1212	4241	4143	1123	2
50.		Turn to the blue page for problem 7. It is a blank page. Now you are really on your own. But if you keep following the same system you should be able to find the rule for matching without any trouble. If you forget what to do, look at the card which tells you the system to follow.			(Blank)		
51.	C	No instruction.	1221	2224	2114	1112	2
52.		No instruction.	1212	3223	3124	1144	1
53.		No instruction.	2112	3143	4144	4234	1
54.		No instruction.	1221	3231	3121	1123	2
55.		No instruction.	1212	1241	1144	4124	1
56.		No instruction.	2211	2213	1113	1131	1

SH Lesson 6

Frame No.	Correct Concept	Commentary	Slide Description Type	Ex. 1	Model	Ex 2	Correct Exemplar
57.		Turn to the yellow page for problem 8.			(Blank)		
58.	S	No instruction.	1122	1214	1232	4132	2
59.		No instruction.	2112	1241	3242	3122	2
60.		No instruction.	2121	3213	2233	2132	1
61.		No instruction.	1221	3131	3221	2222	1
62.		No instruction.	2121	3144	4114	4212	1
63.		No instruction.	1122	2123	2132	4232	2
64.		Turn to the white page for problem 9. This is your last problem. See how quickly you can find the correct rule for matching.			(Blank)		
65.	S	No instruction.	2211	2213	2213	3121	1
66.		No instruction.	1212	2113	2211	1221	2
67.		No instruction.	2112	1234	3231	3141	2
68.		No instruction.	1221	1231	1111	3112	1
69.		No instruction.	2121	4142	3122	3221	1
70.		No instruction.	1122	4234	4242	1142	2
71.		That was very good work. That's all for today.			(Blank)		

SH Lesson 7

Frame No.	Correct Concept	Commentary	Type	Slide Description Ex. 1	Model	Ex. 2	Correct Exemplar
1.		Today is the last day we will have to practice the rule for matching in the matching game. Because we want you to get used to working without any help, your booklets will have only blank sheets of paper. But you still have your system cards to remind you of the way to go about finding the correct rule for each problem. Let's try the first one now. Choose a rule for matching. Write it on the first page...			(Blank)		
2.	C	Look at the slide...Press a button for the picture which matches by the rule you have written down...If you get a green light, use this rule for matching the next slide; if you get a red light, cross out the rule and write another one...	1212	1241	1144	4124	1
3.		Look at the slide...Press the button for the matching picture...If you get a red light you do not have the correct rule for matching, even if you got a green light with this rule the first time. You have to get two green lights in a row before you can be sure you have the correct rule...	2112	3143	4144	4234	1
4.		Match this slide in the same way...	2211	2213	1113	1131	1
5.		Use the same rule...If you get a red light, even if you got a green light last time, you don't have the correct rule. Cross out the rule you have written down and try another rule...	1212	3223	3124	1144	1
6.		Now try the rule for matching...	1221	2224	2114	1112	2
7.		Match in the same way...	1221	3231	3121	1123	2
8.		Turn the page for problem 2. Find the rule here in the same way. Choose a rule for matching. Write it down...			(Blank)		
9.	Z	Use your rule for matching...If you get a red light, cross out this rule and try another one...	2112	1234	4232	4112	1

SH Lesson 7

Frame No.	Correct Concept	Commentary	Slide Description Type	Ex. 1	Model	Ex. 2	Correct Exemplar
10.		Again, match by the rule you have written down...	1122	1124	1141	3241	1
11.		The same rule...If you get a red light, cross out the rule and	2121	1142	2122	2221	1
12.		Do the same thing here...	2211	4221	1121	1143	2
13.		Match by the same rule...	1221	2214	2134	1131	2
14.		Again, the same rule...	1122	4131	4143	3243	1
15.		Turn the page and choose a rule for this problem. Write it down...			(Blank)		
16.	Z	Match by the rule you have chosen...If you get a red light, cross out your rule and write another one...	1212	3214	3113	1123	2
17.		Again, match by the rule you have written down...If you get a red light, cross out your rule and write another one.	1122	1132	1114	2214	1
18.		Match with the same rule...	1212	4241	4143	1123	2
19.		Match in the same way here...	2112	2122	1124	1234	1
20.		Use your rule for matching...	1122	4212	4244	3144	1
21.		Again, the same rule...	1221	2221	2111	1113	2
22.		Turn the page and write a rule for matching this problem. Now I'm not going to give any more help. Just keep on following the same system for finding the rule for each problem. If you forget the rules for matching, look at the rule card. If you forget the steps for finding the correct rule, look at the system card. See how well you can follow the system for finding the rule for matching.			(Blank)		

SH Lesson 7

Frame No.	Correct Concept	Commentary	Slide Description				Correct Exemplar
			Type	Ex. 1	Model	Ex. 2	
23.	S	No instruction.	2121	3213	2233	2132	1
24.		No instruction.	1221	3131	3221	2222	1
25.		No instruction.	1122	2123	2132	4232	2
26.		No instruction.	2112	1241	3242	3122	2
27.		No instruction.	2121	3144	4114	4212	1
28.		No instruction.	1122	1214	1232	4132	2
29.		Turn the page. Find the rule for this problem in the same way.			(Blank)		
30.	S	No instruction.	2112	3234	4232	4122	2
31		No instruction.	1122	1241	1223	2123	2
32.		No instruction.	2121	3132	1112	1213	1
33.		No instruction.	1212	3121	3222	2222	2
34.		No instruction.	2211	3233	2133	2142	1
35.		No instruction.	2112	1144	4143	4213	2
36.		This is a different problem. Find the rule in the same way.			(Blank)		
37.	N	No instruction.	1122	4242	4224	3124	1
38.		No instruction.	1221	1231	1141	2142	1

SH Lesson 7

Frame No.	Correct Concept	Commentary	Slide Description Type	 Ex. 1	 Model	 Ex. 2	Correct Exemplar
39.		No instruction.	2121	2232	4212	4111	2
40.		No instruction.	2211	2211	4111	4143	2
41.		No instruction.	1221	2213	2133	1132	1
42.		No instruction.	1122	2141	2114	3214	1
43.		Turn to the next page. Now find the rule for this problem.			(Blank)		
44.	N	No instruction.	2112	3212	2213	2133	2
45.		No instruction.	1212	3223	3223	1132	1
46.		No instruction.	1221	3121	3211	4212	1
47.		No instruction.	1221	3242	3132	1131	1
48.		No instruction.	2112	3234	4232	4122	2
49.		No instruction.	1212	4143	4244	2214	1
50.		Here's another problem.			(Blank)		
51.	N	No instruction.	2112	3234	4232	4122	2
52.		No instruction.	1122	1241	1223	2123	1
53.		No instruction.	2121	3132	1112	1213	2
54.		No instruction.	1212	3121	3222	2212	1
55.		No instruction.	2211	3233	4143	2142	2

SH Lesson 7

Frame No.	Correct Concept	Commentary	Type	Slide Description			Correct Exemplar
				Ex. 1	Model	Ex. 2	
56.		No instruction.	2112	1144	4143	4213	2
57.		This is the last problem. Try to find the rule for matching as quickly as possible.			(Blank)		
58.	C	No instruction.	1212	4241	4144	3134	1
59.		No instruction.	1122	3241	3223	1123	2
60.		No instruction.	2121	1232	3222	3121	2
61.		No instruction.	1221	4114	4234	3233	2
62.		No instruction.	2211	4214	2114	4123	1
63.		No instruction.	1212	1211	1112	3142	1
64.		That was very good. That's all for today.					

4. The criterion tests

IMMEDIATE POSTTEST

(Form I)

Note: For all the posttest problems, general instruction was given only at the beginning of the test. The commentary, and the slides presented for the program, were as follows:

Frame No.	Commentary
1.	Today we are going to see how quickly you can find the matching rule for each problem without help. You still have the rule card to remind you just in case you forget what rules to use. You also have your booklet and pencil. Try to follow the same systems you have been using up till now. Let's see how many green lights you can get.

	Correct Concept	Type	Ex. 1	Model	Ex. 2	Correct Exemplar
2.	S	1122	-1214	1232	4132	2
3.		2112	1241	3242	3122	2
4.		2121	3213	2233	2132	1
5.		1221	3131	3221	2232	1
6.		1122	2123	2132	4232	2
7.		2121	3144	4114	4212	1

Frame No.	Correct Concept	Type	Ex. 1	Model	Ex. 2	Correct Exemplar
8.		Here's a new problem.				
9.	Z	2112	1234	4232	4112	1
10.		1122	1124	1141	3241	1
11.		2121	1142	2122	2221	1
12.		2211	4221	1121	1143	2
13.		1221	2214	2134	1131	2
14.		1122	4131	4143	3243	1
15.		Now find the rule for this problem.				
16.	C	1312	1241	1144	4124	1
17.		1221	3231	3121	1123	2
18.		2211	2211	1113	1131	1
19.		2112	3143	4144	4324	1

IMMEDIATE POSTTEST

(Form I)

Note: For all the posttest problems, general instruction was given only at the beginning of the test. The commentary, and the slides presented for the program, were as follows:

Frame No.	Commentary
1.	Today we are going to see how quickly you can find the matching rule for each problem without help. You still have the rule card to remind you just in case you forget what rules to use. You also have your booklet and pencil. Try to follow the same systems you have been using up till now. Let's see how many green lights you can get.

	Correct Concept	Type	Ex. 1	Model	Ex. 2	Correct Exemplar
2.	S	1122	1214	1232	4132	2
3.		2112	1241	3242	3122	2
4.		2121	3213	2233	2132	1
5.		1221	3131	3221	2222	1
6.		1122	2123	2132	4232	2
7.		2121	3144	4114	4212	1

Frame No.	Correct Concept	Type	Ex. 1	Model	Ex. 2	Correct Exemplar
8.		Here's a new problem.				
9.	Z	2112	1234	4232	4112	1
10.		1122	1124	1141	3241	1
11.		2121	1142	2122	2221	1
12.		2211	4221	1121	1143	2
13.		1221	2214	2134	1131	2
14.		1122	4131	4143	3243	1
15.		Now find the rule for this problem.				
16.	C	1212	1241	1144	4124	1
17.		1221	3231	3121	1123	2
18.		2211	2213	1113	1131	1
19.		2112	3143	4144	4234	1

Posttest

Frame No.	Correct Concept	Type	Ex. 1	Model	Ex. 2	Correct Exemplar
20.	C	1221	2224	2114	1112	2
21.		1212	3223	3124	1144	1
22.		Now do this one.				
23.	C	1122	3241	3223	1123	2
24.		1212	4241	4144	3134	1
25.		1221	4114	4234	3233	2
26.		2121	1232	3222	3121	2
27.		2211	4214	2114	2143	1
28.		1212	1211	1112	3142	1
29.		Find the rule for this problem.				
30.	N	1212	3223	3122	1132	1
31.		1221	3121	3211	4212	1
32.		1212	4143	4244	2214	1
33.		2112	3212	2213	2133	2
34.		1221	3242	3132	1131	1
35.		2112	3234	4232	4122	2

Posttest B: Transfer to New Instances of the Same Concepts

Frame No.	Correct Concept	Type	Ex. 1	Model	Ex. 2	Correct Exemplar
36.		Now we are going to have some different pictures, but the rules for matching are just the same: number, size, color, and shape. See how quickly you can find which of these rules is the correct one for each of the problems.				
37.	S	2211	1287	3187	3176	1
38.		1221	3285	1275	1177	1
39.		2112	3277	4275	4155	2
40.		1212	4256	4157	2167	2
41.		1122	2286	2278	3178	2
42.		2112	4265	3267	3177	2
43.		Now find the rule for this problem.				
44.	Z	2112	1286	4285	4165	1
45.		1212	1158	1256	4286	2
46.		2211	4266	3166	3178	2
47.		1221	2277	2157	4156	2
48.		1122	3275	3258	2158	1

Transfer A: Transfer to New Instances of the Same Concepts

Frame No.	Correct Concept	Type	Ex. 1	Model	Ex. 2	Correct Exemplar
49.	Z	2112	3178	1175	1285	1
50.		Now do this one.				
51.	C	1212	2288	2185	3155	1
52.		2211	4186	1286	1267	1
53.		1221	3286	3156	1158	2
54.		2211	2268	4168	4157	1
55.		1212	3177	3278	2268	1
56.		1221	1266	1176	3177	2
57.		Find the rule for this problem.				
58.	N	2121	4277	2257	2156	2
59.		1122	3167	3178	2278	1
60.		1221	4168	4258	3255	1
61.		2211	3178	2278	2286	2
62.		1212	1165	1268	3258	1
63.		2112	7167	2165	2275	2
64.		Now do this one.				

Frame No.	Correct Concept	Type	Ex. 1	Model	Ex. 2	Correct Exemplar
65.	Z	1212	4257	4156	1176	2
66.		1122	1278	1257	4157	1
67.		1221	4168	4258	3255	2
68.		1212	4257	4156	1176	2
69.		2112	4167	2165	2275	1
70.		2211	4186	1286	1267	2

That was very good. That's all for today. Tomorrow we'll come back and see some different pictures.

NOTE: Since the materials for Transfer B and C were completely unfamiliar to the children, the first four (4) slides in each program presented the new pictures and concepts. For the rest of the programs there were no additional instructions. Missing numbers in the programs indicate blank slides between problems.

TRANSFER B: TRANSFER TO NEW CONCEPTS (Geometric Forms)

Frame No.	Correct Concept	Type	Ex. 1	Model	Ex. 2	Correct Exemplar
2.	Design	1122	3233	3211	2111	1
3.	Border	1221	3112	3222	1223	1
4.	Tip	2112	1123	2122	2232	1
5.	Bar	1221	1221	1131	2133	2
7.	Design	2112	2112	1111	1221	2
8.		2211	1131	3231	3213	2
9.		1221	1221	1131	2133	1
10.		1122	3233	3211	2111	1
11.		2112	1123	2122	2232	2
12.		1221	3112	3222	1223	1
14.	Tip	1212	2131	2232	1212	2
15.		1122	3111	3123	2223	1
16.		1221	1121	1231	2233	2
17.		2211	1212	3112	3121	2
18.		1122	3231	3212	1112	1
19.		2211	3113	1213	1231	2
21.	Bar	2112	2231	1233	1113	1
22.		1122	2113	2121	3221	2
23.		1212	3131	3232	2222	1
24.		1221	2123	2213	3211	2
25.		1212	2211	2113	2133	1
26.		2121	1112	3122	3223	2
28.	Border	2121	3113	2123	2221	1
29.		1221	1132	1212	2211	1

Transfer B: Transfer to New Concepts (Geometric Forms)

Frame No.	Correct Concept	Type	Ex. 1	Model	Ex. 2	Correct Exemplar	Frame No.	Correct Concept	Type	Ex. 1	Model	Ex. 2	Correct Exemplar
30.		1212	1221	1122	3132	2	36.		1122	1233	1211	2111	1
31.		2211	1121	3221	3213	1	37.		2112	2112	1111	1221	2
32.		2112	1211	2212	2132	2	38.		2211	1131	3231	3213	2
33.		2121	3123	1133	1232	1	39.		1221	1221	1131	2133	1
35.	Design	2121	3133	1123	1222	2	40.		1122	3233	3211	2111	1

TRANSFER C: TRANSFER TO NEW CONCEPTS (Earth; Air; Living; Non-Living)

2.	Earth	1212	1010		0101	1	13.		1212	5050		0505	2
3.		2112	0550		1001	2	14.		2121	0606		6060	1
4.		2112	0110		2002	2	15.		2112	0880		6006	2
5.		1212	2020		0202	1	17.	Not Living	2121	0707		7070	1
7.	Living	2112	0660		3003	1	18.		1221	7007		0770	1
8.		1212	3030		0303	1	19.		1221	8008		0220	1
9.		2121	0404		4040	2	20.		1212	8080		0808	2
10.		1221	4004		0220	2	22.	Air	2121	0707		6060	1
12.	Not Living	2112	0330		5005	2	23.		1221	1001		0880	2

Transfer C: Transfer to New Concepts (Earth; Air; Living; Non-Living)

Frame No.	Correct Concept	Type	Ex. 1	Model	Ex. 2	Correct Exemplar
24.		2112	0220		9009	1
25.		2121	0909		9090	1
27.	Air	1221	1001		0440	2
28.		1212	3030		0101	2
29.		1212	6060		0505	2
30.		2112	0990		7007	1

Retention Test (Form II of Posttest A)

Frame No.	Commentary
1.	Hello again! I wonder how many of you can remember the system we learned for finding the correct rule in the matching game? The rule card in the front of your booth will remind you that the four rules are number, size, color, and shape. Now take your booklets and circle one of these rules.

Frame No.	Correct Concept	Type	Ex. 1	Model	Ex. 2	Correct Exemplar
2.	Number	2211	1114	3214	3221	2
3.		2121	4244	2234	2132	2
4.		1221	4213	4123	2122	1
5.		2211	4234	3134	3123	2
6.		1212	2241	2143	1123	1
7.		2112	3111	1114	1234	2
8.		Turn to the next page in your booklet. Circle a rule for matching.				
9.	Color	1122	3122	3114	2214	2
10.		2112	2223	1221	1141	1
11.		1122	2143	2121	1221	2
12.		1212	2141	2243	1223	1
13.		1122	2144	2133	4233	2
14.		1122	1221	2143	2143	2
15.		Follow this same method for finding the correct rule on the next problem.				
16.	Shape	2112	1241	2243	2123	2
17.		1221	4111	4231	1234	1

Retention Test (Form II of Posttest A)

Frame No.	Correct Concept	Type	Ex. 1	Model	Ex. 2	Correct Exemplar
18.		2121	3233	1223	1122	1
19.		1212	3244	3141	1131	2
20.		2112	1144	4143	4213	2
21.		1122	1112	1131	3231	2
22.	Size	Find the rule for each of these problems.				
23.		1221	2221	2111	1113	2
24.		1122	4212	4244	3144	1
25.		2112	2122	1124	1234	1
26.		1212	4241	4143	1123	2
27.		1122	1132	1114	2214	1
28.		1212	3214	3113	1123	2
29.	Size	Find the rule in the same way.				
30.		2211	2213	3113	3121	2
31.		1212	2113	2211	1221	2
32.		2112	1234	3231	3141	1
33.		2121	4142	3122	3221	1

Frame No.	Correct Concept	Type	Ex. 1	Model	Ex. 2	Correct Exemplar
34.		1221	1231	1111	3112	2
35.		1121	4234	4242	1142	1
36.	Color	Now we are going to have some different pictures, but the rules for matching are the same: number, size, color and shape. See how quickly you can find which of these rules is the correct one for each problem.				
37.		2121	1232	3222	3121	2
38.		2211	4214	2114	2143	1
39.		1212	1211	1112	3142	1
40.		1122	3241	3223	1123	2
41.		1221	4114	4234	3233	2
42.		1212	4241	4144	3134	1
43.	Color	This is a new problem. Find the rule in the same way.				
44.		1221	3231	3121	1123	2
45.		1212	3223	3124	1144	1
46.		2211	2213	1113	1131	1

Frame No.	Correct Concept	Type	Ex. 1	Model	Ex. 2	Correct Exemplar
47.		1221	2224	2114	1112	2
48.		1212	1241	1144	4124	1
49.		2112	3143	4144	4234	1
50.	Number	Now find the rule for the next problem.				
51.		2112	3212	2213	2133	2
52.		1212	4143	4244	2214	1
53.		1221	3242	3132	1131	1
54.		1212	3223	3122	1132	1
55.		2112	3234	4232	4122	2
56.		1221	3121	3211	4212	1
57.	Shape	Here's another problem. Find the rule.				
58.		1122	1214	1232	4132	2
59.		2121	3144	4114	4212	1
60.		2112	1241	3242	3122	2
61.		1122	2123	2132	4232	2
62.		1221	3131	3221	2222	1
63.		2121	3213	2233	2132	1
64.	Size	Now find the rule for matching in this problem.				
65.		1122	4131	4143	3243	1
66.		1221	2134	2134	1131	2
67.		2211	4221	1121	1143	2
68.		2121	1142	2122	2221	1
69.		1122	1124	1141	3241	1
70.		2112	1234	4231	4112	1
71.		That was very good work.				